# APPENDIX I

Drainage Master Plan for Cordova Hills

# *Drainage Master Plan*

## *For*

Cordova Hills

## *County of Sacramento, CA*

## *Control #2008-00142*

PREPARED FOR:
**SACRAMENTO COUNTY WATER AGENCY**
WATER RESOURCES DIVISION
827 7TH STREET, ROOM 301
SACRAMENTO, CA 95814

PROJECT DEVELOPER:
**CORDOVA HILLS OWNERSHIP GROUP**
5241 ARNOLD AVENUE
MCCLELLAN, CA 95652

PREPARED ON MAY 31, 2011
Sacramento County Approval July 27, 2011

PREPARED BY:
**MACKAY & SOMPS CIVIL ENGINEERS, INC.**
1552 EUREKA ROAD, SUITE 100
ROSEVILLE, CA 95661-3040

(Elevations noted are based on North American Vertical Datum of 1988 (NAVD 88))

# TABLE OF CONTENTS

# TABLES INDEX



# EXHIBITS INDEX

# APPENDIX INDEX

# 1.0 Executive Summary

The Cordova Hills Special Planning Area (the Project) is a proposed 2,668+/- acre mixed-use community located within the Sacramento County Grant Line East Planning Area. The Project consists of low to high-density single-family residential, multi-family residential units, retail, mixed-use areas, schools (including the proposed private University of Sacramento campus), parks, open spaces, and community facilities.

The Project is located generally between Grant Line Road and Scott/Stonehouse Road, south of White Rock Road and north of Jackson Road in northeastern Sacramento County. Refer to **Exhibit A: Vicinity Map** to see the location of the Project. The Project site is bounded by Grant Line Road and the City of Rancho Cordova City limits on the west. The eastern boundary is contiguous with the County of Sacramento Urban Services Boundary. Glory Lane constitutes the Project's the northern boundary, while the southern and southwestern boundaries are adjacent to undeveloped County of Sacramento property, the County of Sacramento Urban Services Boundary and the Kiefer Landfill. The Drainage Master Plan for the Project is based on the proposed land use plan dated March 8, 2011, as prepared by WHA. Refer to **Exhibit B: Land Use Plan** to see the Project land uses.

This Drainage Master Plan for the Project analyzes drainage impacts resulting from development of the proposed land uses depicted in **Exhibit B**. The analysis defines how the proposed development can occur in a responsible and safe manner consistent with all applicable standards and regulations and how potential impacts on existing receiving waters including the Upper Laguna Creek Tributary, an un-named Deer Creek Tributary, and Carson Creek can be fully mitigated to existing or better than existing conditions. The analysis is being incorporated into an Environmental Impact Report being prepared by the County of Sacramento, acting as the Lead Agency under the requirements of the California Environmental Quality Act (CEQA). The document will support the U.S. Clean Water Act, Section 401 and 404 permitting processes.

The Project can develop as proposed by constructing on-site combination Flood and Flow Duration Control Detention Basins that mitigate for the developments impacts. These detention basins include a wet water quality basin below the discharge elevation of the detention and flow duration control discharge structures. Summer nuisance flows will be handled through general evaporation and percolation into the ground through a combination of LID measures, specially designed and constructed percolation boxes connected by small drainage pipes to pre-determined drainage inlets, and percolation trenches incorporated into the bottom of detention basins. In combination with the wet water quality basins, summer nuisance flows will thus be prevented from entering the receiving waters.

Potential impacts due to hydromodification on the Upper Laguna, Deer, and Carson Creek watersheds are managed and mitigated through a flow duration control approach. The proposed detention/water quality basins have been modified through the incorporation of flow duration control structures to control discharge into receiving waters that would otherwise increase channel erosion above an existing or natural condition. These flows have been found to range from approximately 25% of the 2-year storm up to and including the 10-year storm.

Flood control via the Flow Duration Control Basins reduces the Project developed stormwater runoff rates calculated by the Sacramento Method for the 10-year 24-hour storm and the 100-year 24-hour storms to less than the pre-development peak flow rates for the same design storms.

With the implementation of the drainage facilities identified in this report, the Project can develop in a responsible and safe manner consistent with all applicable standards and regulations without negatively impacting the pre-development runoff volume, stage, water quality, and hydromodification of the Upper Laguna Creek Tributary, un-named Deer Creek Tributary, and Carson Creek watersheds.

# 2.0 Introduction

## 2.1 Overview

The Project is a proposed 2,668+/- acre mixed-use community located within the Sacramento County Grant Line East Planning Area. The Project consists of low to high-density single-family residential, multi-family residential units, retail, mixed-use areas, schools (including the proposed private University of Sacramento campus), parks, open spaces, and community facilities. The Project site is bounded by Grant Line Road and the City of Rancho Cordova City limits on the west. The eastern boundary is contiguous with the County of Sacramento Urban Services Boundary. Glory Lane constitutes the Project's northern boundary, while the southern and southwestern boundaries are adjacent to undeveloped County of Sacramento property and the County of Sacramento Urban Services Boundary and the Kiefer Landfill.

The Project area consists of undeveloped land with poor agricultural soils. The area has been used primarily for cattle grazing. The site contains two distinct types of terrain: on the west side adjacent to Grant Line Road, site elevations range from 210± feet in the south to 258± feet along the ridge of the Upper Laguna Creek watershed. This portion of the site is gently rolling with no deeply incised drainage channels; this Upper Laguna Creek Tributary may be described as a broad, shallow swale.

The central and eastern portions of the site are located within the Deer and Carson Creek watersheds, respectively. This portion of the site consists of more steeply sloping topography, being a system of north south main ridges and east-west spur ridges with deeply incised swales. The primary drainage feature in the center of the Project is an unnamed tributary to Deer Creek that extends through the site, while Carson Creek, also a tributary to Deer Creek, flows along the eastern boundary. The site elevations range from 128± feet in the south to 254± feet along the highest ridge.

This Drainage Master Plan (Cordova Hills DMP) for the Cordova Hills Special Planning Area analyzes the onsite Upper Laguna Creek Tributary to just upstream of the convergence with the Upper Laguna Creek main branch located just west of Grant Line Road, the unnamed Deer Creek Tributary to a location south of the Project, and the small onsite sub-sheds of Carson Creek. Refer to **Exhibit C: Drainage Study Area Map** to see the limits of this drainage study.

## 2.2 Purpose

The Cordova Hills SPA Drainage Master Plan analyzes drainage impacts resulting from development of the proposed land uses depicted in Exhibit B. The analysis defines how the proposed development can occur in a responsible and safe manner consistent with all applicable standards and regulations and how potential impacts on existing receiving waters can be fully mitigated to existing or better than existing conditions. The analysis is being incorporated into an Environmental Impact Report being prepared by the County of Sacramento, acting as the Lead Agency under the requirements of the California

Environmental Quality Act (CEQA). The document will support the U.S. Clean Water Act, Section 401 and 404 permitting processes.

This study adheres to specific requirements for the planning and analysis of drainage facilities as set forth in:

1. the Storm Drain Design Standards of the Municipal Services Agency of Sacramento County Department of Water Resources,
2. the Sacramento County Water Agency Drainage Ordinance,
3. the Sacramento City/County Drainage Manual Volume 2: Hydrology Standards,
4. the Sacramento County Water Agency Code Titles 1 and 2,
5. the Sacramento County Floodplain Management Ordinance,
6. the Stormwater Quality Design Manual for the Sacramento and South Placer Regions, and
7. the Department of Water Resources Plan Submittal Take-In Check List.

The study was prepared under the responsible supervision of Ken Giberson, a State of California registered Civil Engineer.

## 2.3 Federal Emergency Management Agency (FEMA) Information

The most recent FEMA Flood Insurance Study (FIS) Flood Insurance Rate Map (FIRM), revised September 30, 1988, identifies the Project as being located in the un-shaded Zone X classification.

The eastern boundary of the project is coterminous with the shaded Zone A 100-year floodplain of Carson Creek. The effective floodplain model for Carson Creek is not available at this time. Unlike Carson Creek, FEMA has not mapped the existing floodplains of the Upper Laguna Creek or the unnamed Deer Creek tributaries within the Project. Refer to **Exhibit D: Existing Conditions Floodplain Map** and **Exhibit E: Developed Conditions Floodplain Map** to see the existing and post development floodplain conditions. In keeping with Federal and State requirements, as well as the County of Sacramento Floodplain Management Ordinance, the existing and proposed conditions floodplain within and adjacent to the project must be mapped with a FEMA approved LOMR. FEMA submittals and approval must be secured prior to recordation of any final maps located within the respective sub-sheds. The hydrologic and hydraulic analyses contained within this report will eventually form the basis of the required floodplain mapping for FEMA submittals.

## 2.4 South Sacramento Habitat Conservation Plan (SSHCP)

The purpose of the draft South Sacramento Habitat Conservation Plan (SSHCP) is to consolidate environmental efforts to protect and enhance wetlands (primarily vernal pools) and upland habitats to provide ecologically viable conservation areas. Its goals are to minimize regulatory hurdles and streamline the environmental permitting process for development projects. The SSHCP will be an agreement between state/federal wildlife and wetland regulators and local jurisdictions, which will allow land owners to engage in the "incidental take" of listed species (i.e., to destroy or degrade habitat) in return for conservation commitments from local jurisdictions.

The Cordova Hills SPA is located within the geographic scope of the SSHCP, which includes U.S. Highway 50 to the north, Interstate 5 to the west, the Sacramento County line with El Dorado and Amador Counties to the east, and San Joaquin County to the south. Sacramento County is partnering with the incorporated cities of Rancho Cordova, Galt, and Elk Grove as well as the Sacramento Regional County Sanitation District and Sacramento County Water Agency to further advance the regional planning goals of the SSHCP.

Based on the SSHCP promises of a number of stakeholder benefits, including streamlined regulatory compliance, reduced overall, planning, analysis, and mitigation costs, as well as unlisted species protection through a coordinated regional approach, Cordova Hills' proposed habitat preservation and mitigation plan is consistent with the known aspects the draft SSHCP identifies for the Project area. Nonetheless, as it is impossible to project the processing time line of the draft SSHCP and the ultimate final contents and mitigation requirements of the SSHCP, the developers of the Cordova Hills SPA have filed and are processing an individual Section 404 permit application under the U.S. Clean Water Act with the U.S. Army Corps of Engineers and will apply for a Clean Water Act Section 401 water quality certification from the Central Valley Regional Water Quality Control Board. In addition, they will also seek any necessary streambed alteration agreement with the California Department of Fish and Game.

## 2.5 Previous Studies

The onsite drainages traversing the Project have not previously been studied. However, the un-named Upper Laguna Creek Tributary traversing the plateau area of the Project just east of Grant Line Road does combine with the main branch of Upper Laguna Creek a short distance downstream and west of Grant Line Road.

The "Draft Regional Master Drainage Study for the SunCreek Specific Plan" dated December 2008, prepared by MacKay & Somps analyses the undeveloped existing Upper Laguna Creek watershed. The SunCreek study utilized the following drainage studies as a reference:

- "Final Master Drainage Study, Sunrise-Douglas Community Plan Area, Sacramento California" dated October 16, 1998 prepared by the Spink Corporation.

- "Drainage Study Montelena, Including Sections for Anatolia 1 & 2 Updated Ultimate Conditions and As-Built Facilities Summary" (Montelena Drainage Study) dated September 2007.

- "Summary of Sunrise Boulevard Flood Protection Study" dated February 5, 2010 prepared by West Yost Associates.

Triangle Rock Regional Detention Issue

The County proposes to construct a regional detention facility downstream of the project on Laguna Creek near the intersection of Jackson Road and Sunrise Blvd. This facility will be constructed in a surface mining pit currently used to generate rock and sand for building materials. This facility is needed to attenuate the peak runoff in Laguna Creek to relieve flooding problems further downstream.

This regional facility will, however, provide little or no benefit to the upstream areas within the Laguna Creek watershed. While the western most 725+/- acres of the Cordova Hills site lies within the Laguna Creek watershed, regulatory requirements to attenuate peak flows leaving the project site to existing levels and to mitigate hydromodification impacts of development of the Cordova Hills site effectively result in this project not contributing to the downstream flooding problem. Accordingly, there is no nexus between development of the project area and the need for the regional detention facility.

Sunrise/Jackson Flooding Problem

Likewise, development of the Cordova Hills site will not contribute to the local flooding problems that exist in the vicinity of the Jackson Road/Sunrise Blvd. intersection just upstream of the proposed regional detention facility. The regulatory requirements to attenuate peak flows leaving the project site to existing levels and to mitigate hydromodification impacts of development of the Cordova Hills site effectively result in this project not contributing to the localized flooding problem at this intersection. Accordingly, there is no nexus between development of the project area and the need for the flood improvements in the vicinity of this intersection.

No previous studies were found for the unnamed Deer Creek Tributary or the segment of Carson Creek located in the Project's vicinity.

## 2.6 Existing Conditions

The Project lies within the Upper Laguna, Deer, and Carson Creek watersheds. The majority of the existing land within the Drainage Study Area is undeveloped property primarily used as cattle grazing land. The Drainage Study Area can be characterized as having two distinct types of terrain:

On the west side adjacent to Grant Line Road, site elevations range from 130± feet in the south to 280± feet along the ridge of the Upper Laguna Creek watershed, north of the project. This portion of the site is gently rolling with no deeply incised drainage channels; this Upper Laguna Creek tributary may be described as a broad, shallow swale that flows under Grant Line Road at the southern extremity.

The central and eastern portion of the site falls within the Deer and Carson Creek watersheds. This portion of the site consists of more steeply sloping topography, being a system of north south main ridges and east-west spur ridges with deeply incised swales. The primary drainage feature in the center of the Project is an unnamed tributary of Deer Creek that extends through the site. The eastern portion of the project slopes toward Carson Creek, the approximate 100-year floodplain boundary of which constitutes the County's Urban Services Boundary along the eastern edge of the Project. The site elevations range from 128± feet in the south to 300± feet along the boundary of the unnamed Deer Creek Tributary, north of the project.

The existing main branch of Upper Laguna Creek originates approximately 8,475+/- feet north of the Project. It traverses the northwest corner of the Project for about 50 feet, before flowing through dual 50-inch diameter CMP pipes under Grant Line Road. It then flows in a southerly direction along the west side of Grant Line Road across the SunRidge and SunCreek projects.

The eastern un-named Upper Laguna Creek Tributary that bisects the Project originates approximately 1,300 feet north of Glory Lane and the Project. It traverses the western half of the project through a number of connected, yet poorly defined, shallow swales, before flowing through dual 62-inch diameter CMP pipes crossing under Grant Line Road at the Project's southwest corner. The tributary then combines with the main branch of Upper Laguna Creek approximately 830' west thereof. Upper Laguna Creek continues in a southerly direction towards State Route 16, alternatively known as Jackson Road or Jackson Highway.

The existing unnamed Deer Creek Tributary commences approximately 9,200-feet north of the Project and, upon leaving the Project, flows southwest for approximately 3,200 feet across undeveloped pasture land before reentering the Project for approximately 1,200-feet. South of the Project, the tributary meanders in a southerly direction for approximately 9,400-feet across undeveloped grass lands, before flowing into Deer Creek north of Kiefer Boulevard.

The small sub-sheds of the Carson Creek watershed that are contained within the project flow directly into Carson Creek along the Project's eastern boundary. The cumulative onsite watershed area for Carson Creek is approximately 609-acres.

The above described watersheds are depicted in **Exhibit F: Pre-Development Watershed Map**.

## 2.7 Soils Information

The soil type classification for each drainage sub shed was determined by using the soils survey of California, Sacramento County. Image files from the U.S. Department of Agriculture were downloaded from their web site and referenced into the drainage exhibits for both pre and post development conditions. The image files were scaled into the overall watershed plats to allow establishment of the various soil type areas (A, B, C, D, E, or F, respectively) within each shed. These areas are used in the Sac Calc model to derive the hydrology. The overall shed is predominately type D soil conditions, with types A, B, and C primarily isolated within the proposed Natural Preserve areas of the Project. Refer to **Exhibit G: Pre-Development Soils Analysis (SCS)** and **Exhibit H: Post-Development Soils Analysis (SCS)** to see the soil classifications within the Project with the existing and developed conditions water shed boundaries superimposed thereon.

## 2.8 Hydrology and Hydraulic Models

In accordance with the current Sacramento City/County Drainage Manual – Volume 2 (Hydrology Standards), runoff hydrographs for existing and developed conditions needed for input into the HEC-RAS model have been calculated using a Windows based application called the Sacramento Calculator (SacCalc) with what is commonly referred to as "the Sacramento Method". The Cordova Hills SPA watershed is located in Rainfall Zone 2 of the Sacramento Method rainfall zone designations.

Hydraulic analyses for water surface elevation assessment purposes have been performed using version 4.1 of the US Army Corps of Engineers HEC-RAS program, using the unsteady state routines. Modeling software used to analyze potential hydromodification on the receiving waters is being discussed in the following section.

## 2.9 Hydromodification Assessment

The Cordova Hills DMP incorporates a hydromodification assessment and mitigation plan for the hydromodification impacts due to development of the Project. The hydromodification assessment assesses the hydrologic and geomorphic impact of the Project relative to existing conditions on the study segments of the Upper Laguna Creek, the unnamed Deer Creek, and Carson Creek watersheds.

Continuous simulation is emerging as the standard approach for assessing hydromodification, because it takes into account the cumulative effect of geomorphically-significant smaller and medium sized events. A continuous simulation model in HEC-HMS with a 49-year 1-hour interval precipitation record was utilized for this analysis to determine an annualized hydrograph. The range of flows that in aggregate is responsible for most channel erosion has been found to be flows that fall between some fraction of the 2-year storm and the 10-year storm. To determine the total amount of work (erosive forces) that existing and proposed conditions runoff does on the receiving waters, the annualized hydrograph was then processed using Mike11 modeling software and the geo-referenced cross sections out of the HEC-RAS model. The total work resulting from post-development runoff hydrographs was then compared to that resulting from the existing conditions hydrographs in order to determine mitigation requirements.

Flow duration control, low impact development (LID), and in-stream approaches are generally used to mitigate the impacts on hydromodification within a water course. Based on the proposed preservation of the receiving waters within and adjacent to the Project area, in-stream approaches were not considered in this study. The LID approach requires a home builder to select materials and implement various techniques which improve the storm runoff water quality and reduces the storm runoff volumes at the source. Since the current entitlement level does not include small-lot tentative map approvals (and as such, detailed subdivision layouts) and as the Project is several years from the start of home construction, the specific LID techniques cannot be determined at this time. The current analysis has therefore been prepared without accounting for the numerical benefit of LID measures. Potential future LID measures are further detailed in the following section.

## 2.10 Low Impact Development

LID emphasizes the conservation and use of available on-site natural resources to protect the environment – especially water. Small-scale LID projects dispersed throughout the watershed combine with point-of-discharge flood control and water quality treatment basins to manage post-development stormwater runoff and maintain or restore pre-development watershed conditions.

LID replaces the traditional development approach of conveying runoff through miles of costly pipes to acres of expansive detention ponds with an approach that mimics nature, using natural vegetation and small-scale treatment systems to retard, treat, and infiltrate stormwater runoff close to where it originates. Reducing the amount of runoff at the source in the first place not only reduces the need for point-of-discharge facilities (detention and water quality basins), but reduces impacts on receiving waters carrying stormwater.

The LID toolbox provides for a variety of environmentally sound and cost-effective techniques including green infrastructure, conservation design, and sustainable stormwater management practices. New development will typically be able to maximize the benefit of advanced stormwater management through the implementation of a number of these tools in combination to replicate the predevelopment hydrology of the site.

Where applicable, LID Techniques may include:

- Preservation of the natural hydrology;
- Stormwater management at the source (close to where rain falls);
- Preservation of natural drainage features and patterns, where possible;
- Retention of existing vegetation, especially when native;
- Creation of a hydrologically rough landscape to slow down stormwater runoff;
- Clustering development;
- Integration of stormwater controls into development design as amenities though a multi-disciplinary design approach at the initial phases of a project;
- Reduction of impervious surfaces;
- Pervious concrete;
- Porous asphalt;
- Permeable pavers;
- Reduction of effective impervious surfaces;
- Rain Gardens;
- Bioretention systems;
- Bio-swales;
- Landscaping with native plants;
- Water conservation and xeriscaping;
- Mulching of landscaped areas;
- Compost amended soils;
- Enhancement of disturbed soils to increase their storage and infiltration potential;
- Green roofs;
- LID education of homeowners and maintenance staff;

As Cordova Hills is not currently seeking small-lot entitlements, final development project layouts are not known at this time. As such, the numerical benefits of actual BMP's and LID features specific to land use and site layout have not been considered in the analysis of point-of-discharge detention and water quality basins required to fully mitigate the development impacts of this project on receiving waters. It is projected that these benefits will be calculated and accounted for prior to actual design of the downstream detention and water quality treatment basins. By presenting the various tools available in the LID tool box to a future developer, provides the groundwork for innovative and site-appropriate stormwater treatment methods that will satisfy current and emerging governmental requirements at the local, State, and Federal level.

Cordova Hills has been utilizing a multi-disciplinary approach that has included planners, engineers, and landscape architects since project inception to incorporate appropriate BMP's and LID features into every facet of the project. From the initial land use plan concepts sensitive to existing terrain and drainage patterns, to engineered street sections incorporating LID swales and a site-appropriate drought-tolerant landscape palette that is nonetheless aesthetically pleasing, this master plan will ensure implementation of an environmentally sound and sustainable community.

Refer to **Exhibit I: Cordova Hills LID Master Plan Concepts** to see a variety of environmentally sound LID features, which may be implemented throughout the Project.

# 3.0 Hydrologic & Hydraulic Modeling

The Cordova Hills DMP analyzes the Existing and Developed Conditions (pre- and post-development conditions) for the Upper Laguna Creek Tributary, the unnamed Deer Creek Tributaries, and the onsite watersheds tributary to Carson Creek. This study utilizes topography that is based on the North American Vertical Datum of 1988 (NAVD 88).

In the first step of the analysis, runoff hydrographs from the various sub-sheds are determined for pre- and post development conditions using the Sacramento Method. Flood control mitigation to reduce post-development peak runoff rates to pre-development levels is then incorporated into the SacCalc models to establish appropriate flood detention volumes.

For the Upper Laguna Creek and Deer Creek Tributaries, the hydrographs derived from Sac Calc were then incorporated into a HEC-RAS "unsteady state" analysis of the receiving waters in order to determine peak stages and the hydraulic grade line resulting from the various design storm events. For this purpose, alignments of the receiving waters and locations of cross sections spaced in accordance with the County's requirements are determined in AutoCAD. Surveyed cross section data is utilized in both scenarios (existing and proposed conditions) to define the hydraulic cross section of the existing channel. The software augments the cross sections and overbank terrain based on the terrain model of the Project Area's topography. The program then exports geospatial data sets that are input into HEC RAS to define the conveyance geometry. The modeler then enters parameters for in-stream structures such as berms and culverts, before running the model. Model output files in GIS format are then imported into ArcMap's HEC GeoRAS extension. Using the channel geometry and computed water surface profiles, inundation depth, and floodplain boundary data sets are then created through HEC GeoRAS.

As the on-site sheds tributary to Carson Creek located adjacent to the Project in aggregate constitute only a very small portion of the much larger overall Carson Creek basin, it was deemed impracticable to prepare detailed hydraulic models of Carson Creek for this general level of entitlements. For these sheds, only SacCalc models for pre- and post-development conditions were run to establish peak runoff rates and associated detention and water quality volumes required for mitigation. It should be noted that these sub-sheds constitute the last development phase of a projected 20-year+/- buildout horizon. It is impossible today to definitively identify final development proposals that may evolve for this area over the projected buildout horizon. Associated drainage impacts may thus very well change along with these evolving development proposals. Only when detailed small-lot development proposals emerge for this area will it be possible to analyze potential Carson Creek floodplain impacts, if any, associated with these proposals.

## 3.1 Existing Condition Models

The "Existing Conditions" of the Drainage Study Area were analyzed in order to obtain a basis for comparison with the "Developed Conditions" model also prepared as part of this analysis. The Existing Conditions are defined by the current land uses and topography within the 4,495± acre Drainage Study Area.

**Exhibit F** depicts the existing conditions watershed map used as the basis for developing the Existing Conditions Model.

The offsite main branch of Upper Laguna Creek barely crosses the northwest corner of the Project, before crossing under Grant Line Road through dual 50-inch CMP pipes and flowing directly into the future SunRidge area. During major storm events, water currently ponds along the east side of Grant Line Road at a few of the CMP pipe locations before eventually cresting Grant Line Road during peak flow events.

As described in Chapter 2 of this study, the onsite Upper Laguna Creek Tributary originates just north of the project, bisects the western half of the project as it flows southward across the plateau area through a series of connected, shallow swales, and eventually crosses under Grant Line Road through dual 62-inch diameter CMP pipes at the project's southwest corner.

The Unnamed Deer Creek Tributary watershed affected by the proposed Project originates roughly 9,200 feet north of the project. Runoff from the shed collects in an existing, sharply incised, natural, cobble-strewn channel. The analysis determined existing 2-, 10-, and 100-year water surface profiles for this channel based on surveyed cross section thereof (on-site) as well as digitally generated cross sections based on LiDAR topography for off-site reaches of the channel.

The onsite Carson Creek sub-sheds either sheet-flow directly into Carson Creek or are tributary to small drainages that in turn flow directly into Carson Creek. The limits of the approximate 100-yr floodplain for Carson Creek as depicted on FEMA FIRM 060262 0250 C were used in the 1993 General Plan to establish the County's Urban Services Boundary (USB) in this area. That boundary also defines the eastern limits of proposed urbanizing areas of the Cordova Hills SPA. Lands beyond the USB up to the Project limits are proposed to remain undeveloped in perpetuity.

Existing Conditions floodplains have been analyzed and mapped as part of this drainage master plan for the Upper Laguna Tributary and the unnamed Deer Creek Tributary (see **Exhibit D: Existing Conditions Floodplains**). Results of the Existing Conditions HEC-RAS analyses for the 10-year 24-hour, 100-year 24-hour, and 100-year 10-day design storm events for the unnamed Upper Laguna Creek and Deer Creek Tributaries are depicted in **Appendices C** and **D**.

## 3.2 Developed Conditions Model

The Developed Conditions Models are based on a fully developed Project. These models utilize the existing conditions models as a starting point and then overlay the proposed land uses of the Project. The remainder portions of the watersheds beyond the Project limits are modeled the same as the existing conditions model (undeveloped), with the exception of the upstream sub-sheds of the unnamed Deer Creek Tributary which was analyzed both under existing and developed conditions for the reasons detailed later in this section.

Refer to **Exhibit J – Post-Development Watershed Map (Study Area)** for a depiction of the sub-shed parameters (including basin locations) used as the basis for determining the Developed Conditions Models. The models include detention basins that were initially sized such that the flow rates within the receiving waters exiting the Project boundary do not exceed the existing conditions flow rates. The detention basins were analyzed for the 10-year 24-hour, 100-year 24-hour, and the 100-year 10-day storms. The 100-year 24-hour storm generated larger detention volume requirements with the exception of basins B8, B14, and B17, in which the 100-year 10-day storm generated the larger detention volume requirements. Therefore, the detention basins are all sized based on the largest determined volume requirement. As described further in Section 3.3: Hydromodification Model, upon incorporation of a Flow Duration Control (FDC) structure to manage hydromodification impacts, the overall basin volume had to be increased by 20% due to the low flow attenuation required for the hydromod. impact mitigation. The modeling of the basins located within the un-named Deer Creek Tributary watershed was then once again revised to incorporate the FDC structures and additional volume requirements as per the hydromodification management recommendations of cbec's analysis included in Appendix A of this study.

To mitigate the impacts the proposed land uses will have on the quality of the storm water runoff, the project proposes to implement wet water quality basins as part of the overall detention and flow duration control basins. The required water quality volumes were determined based on the standards outlined in the Stormwater Quality Design Manual for the Sacramento and South Placer Regions. The calculated volumes as reported in **Table 4** are proposed to be stacked with the detention and hydromodification management volume by excavating each basin below the outlet works designed for flood control and flow duration control purposes. The practical feasibility of this proposal has been analyzed for each of the proposed basins. Design parameters for the various basins are reported in **Tables 2, 3, & 4**.

The off-site main branch of Upper Laguna Creek will be bypassed around the northwest corner of the project to continue to drain directly into the future SunRidge area, mimicking how this area drains during existing conditions storm events. A proposed 4' tall by 8' wide reinforced concrete box culvert will be required to convey this 100-yr runoff combined with the existing conditions runoff from sub-shed L6 beneath Grant Line Road.

The onsite Upper Laguna Creek Tributary east of the main branch discussed above continues to flow through the dual 62-inch diameter CMP pipes beneath Grant Line

Road and into the future SunCreek area, where it converges with the main branch of Upper Laguna Creek.

Unnamed Deer Creek Tributary Upstream Shed Development

To assess the impacts of future upstream development within the un-named Deer Creek Tributary watershed on the practicability of the proposed basins within the Project's portion of said watershed, in addition to the existing conditions model for the entire watershed, 2 developed conditions scenarios were modeled – one that considers Cordova Hills as a "stand alone" developed conditions project with flood control and hydromod. mitigation, with the upstream shed remaining in an existing pre-development condition and one hypothetical scenario that in addition to the Cordova Hills project developed with flood control and hydromod. mitigation also has the upstream tributary shed build out at 50 percent impervious cover. Hypothetical flood control detention basins were then incorporated into the upstream shed to mitigate post-development peak runoff rates for the 10- and 100-yr design storm events back to existing condition flow rates at the Project's upstream boundary. As depicted in **Table 1: Deer Creek Tributary Modeling Scenario Comparison,** under both scenarios, mitigated peak runoff rates are less than existing conditions peak runoff rates for the same 10- and 100-yr design storm events.

Refer to **Appendix E** and **F** for the Developed Conditions HEC-RAS Results (10-year 24-hour, 100-year 24-hour, and 100-year 10-day) for the Upper Laguna Creek and Unnamed Deer Creek Tributaries.

The hydrology of the onsite sub-sheds tributary to Carson creek were analyzed for both existing and developed conditions. Flood control mitigation in the form of detention was then added to the SacCalc model to reduce the peak runoff volumes to existing conditions. The required basins are designed to function in the same way the basins within the Upper Laguna and Deer Creek Tributary sheds are designed to function in that water quality treatment volumes (wet basins) and flow duration control structures with their associated 20% basin volume increases to manage projected hydromodification have been included in the overall basin design and resulting foot print thereof. Required basin parameters are detailed in **Tables 2, 3** and **4**.

## Table 1
## Deer Creek Tributary Peak Flow Rates Modeling Scenario Comparison

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scenario | | | 1 | | 2 | | | | 3 | | | |
| Creek | **100 yr - 24 hr** | | Existing | | Developed Condition with detention | | | | Developed Condition with detention | | | |
| Station | | | Condition | | and upstream existing | | | | (entire watershed) | | | |
| | | | | | | | | | | | | |
| 0+10.31 | Downstream end | | 974.88 | | 968.14 | | | | 926.69 | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| Creek | **10 yr - 24 hr** | | Existing | | Developed Condition with | | | | Developed Condition with detention | | | |
| Station | | | Condition | | upstream existing | | | | (entire watershed) | | | |
| | | | | | | | | | | | | |
| 0+10.31 | Downstream end | | 519.54 | | 494.87 | | | | 510.6 | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Creek | **2 yr - 24 hr** | | Existing | | Developed Condition with | | | | Developed Condition with detention | | | |
| Station | | | Condition | | upstream existing | | | | (entire watershed)* | | | |
| | | | | | | | | | | | | |
| 0+10.31 | Downstream end | | 255.45 | | 226.96 | | | | 287.49 | | | |

Notes: Creek station 0+10.31 is the downstream limit of the study.
all flows shown in cubic feet per second (cfs)
*2-yr peak flows expected to be reduced at the downstream study limits upon hydromodification mitigation implementation concurrent with future development within the watershed upstream of Cordova Hills

**Table 2:**
**Cordova Hills Developed Conditions Detention Basin Volume**

| Basin No. | Det. Bottom Elev. (foot) | Top Elev. [3] (foot) | Basin Side Slope | Flood Control Storage (AF) | Hydromod Storage (AF) | Total Active Storage (AF) | Basin Area (acre) | Basin w/ Buffer [4] (acre) |
|---|---|---|---|---|---|---|---|---|
| **Upper Laguna Creek (Main Branch)** | | | | | | | | |
| B1 | 236 | 243 | 3:1 | 9.358 | 1.9 | 11.2 | 1.876 | 2.25 |
| B2 | 226 | 234 | 3:1 | 6.254 | 1.3 | 7.5 | 1.173 | 1.41 |
| **Upper Laguna Creek tributary** | | | | | | | | |
| B3 | 214 | 224 | 3:1 | 7.508 | 1.5 | 9.0 | 1.21 | |
| B4 | 228 | 238 | 3:1 | 28.19 | 5.6 | 33.8 | 4.33 | |
| B5 | 216 | 225 | 3:1 | 17.07 | 3.4 | 20.5 | 1.93 | |
| **Unnamed Deer Creek tributary**** | | | | | | | | |
| B8* | 170 | 180 | 3:1 | | | 25.3 | 3.13 | |
| B9 | 168 | 175 | 3:1 | | | 9.1 | 1.50 | |
| B10 | 164.5 | 173.2 | 3:1 | | | 4.3 | 0.69 | |
| B11 | 162 | 170 | 3:1 | | | 7.6 | 1.19 | |
| B12 | 159 | 167.4 | 3:1 | | | 3.1 | 0.70 | |
| B13 | 152 | 165 | 3:1 | | | 8.2 | 1.27 | |
| B14* | 152 | 160.7 | 3:1 | | | 21.9 | 3.17 | |
| B15a | 186 | 194.4 | 3:1 | | | 10.2 | 1.62 | |
| B15b | 182 | 190.3 | 3:1 | | | 6.9 | 1.08 | |
| B16 | 174 | 182.7 | 3:1 | | | 14.8 | 2.17 | |
| B17* | 170 | 178.8 | 3:1 | | | 29.0 | 5.08 | |
| B18 | 160 | 168.7 | 3:1 | | | 11.6 | 1.73 | |
| B19 | 129 | 138 | 3:1 | | | 34.1 | 4.76 | 2.00 |
| B32 | 140 | 148 | 3:1 | | | 6.8 | 1.07 | |
| **Carson Creek** | | | | | | | | |
| B23 | 222 | 232 | 3:1 | 1.04 | 0.2 | 1.3 | 0.32 | 0.39 |
| B24 | 148 | 156 | 3:1 | 3.95 | 0.8 | 4.7 | 0.73 | 0.88 |
| B25 | 146 | 156 | 3:1 | 2.02 | 0.4 | 2.4 | 0.54 | 0.65 |
| B26 | 146 | 156 | 3:1 | 1.20 | 0.2 | 1.4 | 0.30 | 0.36 |
| B28 | 157 | 170 | 3:1 | 6.78 | 1.4 | 8.1 | 1.10 | |
| B29 | 152 | 160 | 3:1 | 2.02 | 0.4 | 2.4 | 0.47 | |
| B30 | 142 | 150 | 3:1 | 7.68 | 1.5 | 9.2 | 1.38 | 1.66 |

Notes:

[1] The volume and 100-yr water surface are controlled by the 100-year 24-hour storm, unless noted.
*Denotes that the volume and 100-yr water surface are controlled by the 100-year 10-day storm.
[2] Water Quality Volumes were determined using the Stormwater Quality Design Manual, May 2007, for Wet Ba
[3] 100-Yr Water Surface Elevation is located 1' beneath Top of Basin Elevation noted.
[4] When basins are located in passive recreation (R-2) open space areas, the "basin buffer" area will be seamlessly incorporated into the openspace landscaping and has thus not been noted.
** Basins within un-named Deer Creek Tributary watershed were modeled with the FDC structures and associated basin volume/footprint increases incorporated into the model

The basin volumes listed on the previous page reflect allowances for hydromodification mitigation determined as part of the analysis by cbec (see Section 3.3). Their analysis determined that the overall basin volumes would have to be increased by approximately 20% to account for the storage required for flow duration control of storm events up to the 10-yr recurrence interval. This volume increase then results in an increase of the overall basin foot print by approximately 18%. As described below, the FDC structures and increased basin volumes (footprints) were incorporated into the Sac Calc model for the un-named Deer Creek Tributary to confirm that peak flow rates for the 2-, 10-, and 100-year design storm events at the downstream compliance point could be mitigated to less than or equal to those under existing conditions. The increased volumes and footprints of all basins have been reflected in **Exhibit M: Grading Concept & Basin Location Plan.**

Each detention basin includes a flow duration control (FDC) outlet structure designed as described in the next paragraph. Once through the FDC, runoff from up to the 10-yr storm event drops down into the detention basin discharge pipes. The detention basin discharge pipe outlet structures terminate into energy dissipation structures, which reestablish sheet flow discharge into the open space. The discharge may then be directed into an LID swale, as determined by an environmental consultant. Runoff resulting from storm events greater than the 10-yr event will be allowed to spill out of the basins at calibrated rates across armored spillways of a specified width that are set at specific heights to where the cumulative discharge rates modeled in HEC RAS at the downstream end of the project are no greater than the existing conditions peak flow rates for the 10- and the 100-yr design storm events. A prototypical basin and outlet structure configuration are depicted in **Exhibits K** and **L**.

Each flood control outlet was preliminarily sized using the software system Civil Tools Version 2.4. As described in Appendix A, cbec then utilized the SacCalc hydrology and through an analysis of 49 years of rainfall data synthesized annualized hydrographs for use in a continuous simulation model. After comparing work curves resulting from pre- and post-development runoff within the receiving water (the un-named Deer Creek Tributary), cbec developed stage/discharge curves for each of the proposed flow duration control structures being incorporated into the detention basins to allow a throttling of discharge rates resulting from storms up to the 10-yr event to levels where the total amount of resulting work in the stream (through Q10) matched that existing prior to development. These stage/discharge curves that were simulated via V-notch orifices were then incorporated into the original SacCalc models, replacing the simple flood control orifices used in the first modeling steps. 2-, 10-, and 100-yr design storm events were then modeled for post-development conditions, the resulting hydrographs under detained (mitigated) conditions imported into HEC RAS and the resultant peak runoff rates at the downstream compliance points compared to existing conditions. Basin volumes were then adjusted by increasing their footprints (to increase the attenuation) until the peak flow rates at the compliance points under developed conditions matched or were less than those under existing conditions.

Refer to **Table 3: Cordova Hills Developed Conditions Detention Basins Discharge Flow Rates** for the various basin outlet structure orifice size and outlet pipe configurations, and the maximum detention basin discharge velocities for the basins within the Laguna Creek Tributary and Carson Creek watersheds. For the basins located within the un-named Deer Creek Tributary watershed, i.e. for those basins that were modeled in SacCalc with the FDC structures calibrated via the continuous simulation in place, **Table 3** provides the stage/discharge curves of the FDC orifices included in the model.

It should be noted that sub-sheds D9 OR and D19 OR within the unnamed Deer Creek Tributary shed area will be discharging peak storm drainage runoff in excess of pipe design capacity (i.e. “Nolte Flows”) directly into the unnamed Deer Creek Tributary rather than into detention basins. An overland release path will be provided for this excess runoff to be drained directly into the receiving water. Only runoff from events less than or equal to the design capacity of the underground pipe system (“Nolte flows”) will be conveyed to basins B8 and B18, respectively, to allow for water quality treatment and appropriate flow duration control. The potential impacts of this direct discharge into the receiving waters has been accounted for in adjacent detention basins so as to not increase downstream peak flows for the 10- and 100-yr events above existing conditions. Potential impacts of hydromodification within the receiving water due to these sub-sheds are being mitigated in adjacent basins in a similar fashion through additional flow duration control.

## Table 3:
## Cordova Hills Developed Conditions Detention Basin Discharge Flow Rates

**Table 3 - Cordova Hills Developed Conditions Detention Basin Discharge Flow Rates**

| Basin No. | Orifice | | Outlet Pipes [1] [2] | | |
|---|---|---|---|---|---|
| | Quantity | Diameter (inches) | Quantity | Diameter (inches) | Velocity (fps) |
| **Upper Laguna Creek (main branch)** | | | | | |
| B1 | 1 | 18 | 1 | 30 | 6.7 |
| B2 | 1 | 18 | 1 | 30 | 7.6 |
| **Upper Laguna Creek Tributary** | | | | | |
| B3 | 1 | 15 | 1 | 30 | 6.9 |
| B4 | 1 | 21 | 1 | 36 | 8.4 |
| B5 | 1 | 18 | 1 | 36 | 9.0 |
| **Carson Creek** | | | | | |
| B23 | 1 | 21 | 1 | 30 | 8.1 |
| B24 | 2 | 24 | 1 | 42 | 10.3 |
| B25 | 4 | 12 | 1 | 36 | 8.1 |
| B26 | 3 | 18 | 1 | 42 | 10.2 |
| B28 | 5 | 18 | 1 | 54 | 12 |
| B29 | 6 | 18 | 1 | 48 | 11.3 |
| B30 | 8 | 18 | 1 | 54 | 12.2 |

Notes:
[1] Presumes a pipe slope of 1%
[2] Velocity (feet per second - fps) based on 100-year

| **un-named Deer Creek Tributary Basin Stage/Discharge Curves** | | | | | | | |
|---|---|---|---|---|---|---|---|
| 8 | | 10, B12 | | B16, B18 | | B9, B11, B13, B14, B15a, B15b, B17, B19, B32 | |
| Depth [feet] | Discharge [cfs | Depth [feet] | Discharge [cfs | Depth [feet] | Discharge [cfs | Depth [feet] | Discharge [cfs |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0.13 | 1 | 0.15 | 1 | 0.13 | 1 | 0.13 |
| 2 | 0.44 | 2 | 0.84 | 2 | 0.44 | 2 | 0.44 |
| 3 | 1.22 | 3 | 2.65 | 3 | 1.22 | 3 | 1.22 |
| 4 | 2.61 | 4 | 5.91 | 4 | 2.61 | 4 | 2.61 |
| 5 | 4.73 | 5 | 10.9 | 5 | 4.73 | 5 | 4.73 |
| 6 | 7.66 | 6 | 17.84 | 6 | 7.66 | 6 | 7.66 |
| 7 | 9.8 | 7 | 21.63 | 7 | 9.8 | 7 | 9.8 |
| 8 | 14.08 | 8* | 115.22 | 8* | 40 | 8* | 102.45 |
| 9* | 102.45 | | | | | | |

* Denotes discharge occuring over basin spillway.

The water quality treatment volumes based on wet basin design parameters identified in the Stormwater Quality Design Manual for the Sacramento and South Placer Regions is designed as 'dead storage' located below the flow line of the outlet works of each basin and as such is additive to the flood control and hydromodification volume requirements – see **Table 4: Cordova Hills Water Quality Treatment Volume Requirements**.

## Table 4: Cordova Hills Water Quality Treatment Volume Requirements

| BASIN | SHED | AREA (AC) | WT. PI (%) | "C" | STORAGE* (IN) | STORAGE (FT) | WQV DRY (AC-FT) | WQV WET (AC-FT) |
|---|---|---|---|---|---|---|---|---|
| B23 | C6b | 25.19 | 40.3 | 0.28 | 0.30 | 0.0250 | 0.63 | 0.79 |
| B24 | C7d | 92.30 | 39.8 | 0.28 | 0.3 | 0.0250 | 2.31 | 2.88 |
| B25 | C8d | 42.82 | 33.6 | 0.24 | 0.27 | 0.0225 | 0.96 | 1.20 |
| B26 | C9e | 47.91 | 37.2 | 0.26 | 0.28 | 0.0233 | 1.12 | 1.40 |
| B28 | C10l | 169.79 | 46.4 | 0.32 | 0.34 | 0.0283 | 4.81 | 6.01 |
| B29 | C11e | 79.02 | 53.6 | 0.36 | 0.38 | 0.0317 | 2.50 | 3.13 |
| B30 | C12j | 169.14 | 41.0 | 0.29 | 0.32 | 0.0267 | 4.51 | 5.64 |
| B8 | D12e | 147.76 | 54.7 | 0.37 | 0.40 | 0.0333 | 4.93 | 6.16 |
| B9 | D14c | 33.57 | 40.2 | 0.28 | 0.30 | 0.0250 | 0.84 | 1.05 |
| B10 | D16d | 47.81 | 54.9 | 0.37 | 0.40 | 0.0333 | 1.59 | 1.99 |
| B11 | D18b | 19.70 | 47.4 | 0.32 | 0.35 | 0.0292 | 0.57 | 0.72 |
| B12 | D20d | 43.01 | 66.1 | 0.46 | 0.49 | 0.0408 | 1.76 | 2.20 |
| B13 | D23b | 19.44 | 41.3 | 0.29 | 0.31 | 0.0258 | 0.50 | 0.63 |
| B14 | D25j | 129.89 | 71.4 | 0.51 | 0.55 | 0.0458 | 5.95 | 7.44 |
| B15a | D11b | 40.91 | 55.5 | 0.38 | 0.41 | 0.0342 | 1.40 | 1.75 |
| B15b | D11d | 60.37 | 45.8 | 0.31 | 0.33 | 0.0275 | 1.66 | 2.08 |
| B16 | D13d | 64.69 | 56.7 | 0.38 | 0.42 | 0.0350 | 2.26 | 2.83 |
| B17 | D15i | 131.80 | 54.7 | 0.37 | 0.40 | 0.0333 | 4.39 | 5.49 |
| B18 | D19f | 64.01 | 56.5 | 0.38 | 0.42 | 0.0350 | 2.24 | 2.80 |
| B19 | D31i | 157.51 | 46.3 | 0.32 | 0.34 | 0.0283 | 4.46 | 5.58 |
| B31 | D32 | 95.02 | 5.9 | 0.08 | 0.08 | 0.0067 | 0.63 | 0.79 |
| B1 | L6g | 58.3 | 87.6 | 0.70 | 0.74 | 0.0617 | 3.60 | 4.49 |
| B2 | L7b | 63.5 | 89.4 | 0.72 | 0.76 | 0.0633 | 4.02 | 5.03 |
| B4 | L4h | 171.6 | 65.0 | 0.45 | 0.47 | 0.0392 | 6.72 | 8.40 |
| B5 | L3d | 98.4 | 60.2 | 0.41 | 0.44 | 0.0367 | 3.61 | 4.51 |
| B6 | L9e | 62.8 | 27.3 | 0.21 | 0.23 | 0.0192 | 1.20 | 1.50 |

*See Figure E-3, Appendix E, Page 9 of the Stormwater Quality for the Sacramento and South Placer Regions, Dated May 2007.

## 3.3 Hydromodification Model

cbec, Inc. (cbec) conducted a hydromodification assessment of the potential hydromodification impacts of the Project on the Upper Laguna Creek Tributary, unnamed Deer Creek Tributary, and Carson Creek. cbec also prepared a geomorphic assessment to analyze and document the present channel condition, interpret the historical channel changes, and predict how the proposed development might affect hydromodification, preserve status, and channel preservation given the current geomorphic context of the creeks. Complete copies of these cbec assessments are provided in **Appendix A** and **B** of this Study. The following section of the Cordova Hills DMP briefly discusses the cbec hydromodification assessment, findings, and mitigation recommendations.

The County of Sacramento is in the process of renewing their MS 4 Permit with the Regional Water Quality Control Board (RWQCB). The RWQCB has been requiring jurisdictions seeking renewal of their MS 4 Permit to include hydro-modification mitigation as a requirement for receiving a renewed MS 4 Permit. Anticipating this new requirement by RWQCB and Sacramento County, the Cordova Hills DMP includes hydromodification mitigation measures.

The County of Sacramento has not yet adopted standards for determining impacts due to hydromodification. Thus, the criteria and standards employed in cbec's analysis generally refer to FDC techniques for managing and mitigating hydromodification impacts using flow duration curve matching or similar approaches.

The approached proposed by the Project to mitigate hydromodification impacts on the affected receiving waters is to employ off-line Flow Duration Control structures as depicted in **Exhibit L** incorporated into the various sub-shed detention basins. The detention basins will feature outlet structures that slowly meter out stormwater runoff at rates that meet the objective standards developed to mitigate for hydromodification impacts. In simplistic terms, the Flow Duration Control structure retains all the stormwater runoff generated up to a 10-year event and slowly releases the runoff through a calibrated V-notch or orifice plate set above a very small outlet. The Flow Duration Control structure generally consists of a weir set above the detention basin bottom. The weir has specially calibrated V-notch set 6 inches above a 2-inch outlet pipe set at the bottom of the detention basin. They are connected to a discharge pipe sized to convey the maximum calibrated discharge rate of the Flow Duration Control orifice/V-notch to the receiving water. The V-notch and 2-inch outlet pipe allows for the water behind the weir to accumulate in the detention basin and drain out over an extended period of time (Flow Duration Control). The top of the weir is set at 6 feet above the basin floor and approximately equal to the 10-yr water surface elevation calculated based on the continuous simulation modeling. Storms greater than the 10-yr event (based on an annualized hydrograph derived from 49 years of rainfall data) will be allowed to spill across the FDC weir and out of the basin across an armored spillway of a specified width. The height and width of the spillways are calibrated to adjust the 100-yr storm event attenuation within the basin and associated depth of flow spilling across the weir so that cumulative peak runoff rates at downstream compliance points do not exceed existing conditions peak flow rates.

The hydromodification component in the detention basin below the V-notch drains very slowly through the 2-inch orifice at the bottom of the basin and is therefore largely ineffective in providing flood attenuation. 3:1 side slopes, total basin depths, basin discharge flow lines (and thus overall detention depth) employed in the flood mitigation design portion of the basins have been maintained throughout the flow duration control structure and basin analysis. Based on the hydromodification requirements to attenuate runoff up to the 10-yr event for longer durations and release flows at lower rates, the basin footprint determined via the flood control analysis had to expand to accommodate the additional volume required. The final SacCalc analyses and resulting hydrographs for the un-named Deer Creek Tributary incorporate the FDC structures and associated basin discharge curves determined through the continuous simulation hydromodification mitigation analysis into the model. The resulting hydrographs were then incorporated into the HEC RAS model to determine flow rates and stages within the receiving water, i.e. the un-named Deer Creek Tributary.

Based on the recommendations of the hydromodification management analysis completed by cbec, Inc. (reference **Appendix A, Section 7**), the volume of the basins within the un-named Laguna Creek Tributary and Carson Creek watersheds was increased by 20% while maintaining their flow line and overall depth. The resulting expanded basin footprint and all associated parameters are reflected in **Table 2** and on **Exhibit M: Concept Grading & Basin Location Plan**.

## 3.4 Summer Nuisance Runoff

Another potential impact due to development the Cordova Hills SPA seeks to mitigate is that of runoff occurring during otherwise dry summer months, a phenomenon termed "summer nuisance runoff". Summer nuisance runoff occurs during the dry (summer) season and is mostly generated from a development's residents by over-irrigation of landscaping, washing of vehicles, and other domestic uses that result in water running off of the development. Ephemeral drainages that did not typically receive water runoff during the summer months could become perennial drainages due to summer nuisance runoff. Environmental regulators, including the US Army Corps of Engineers have expressed concern over this potential, desiring instead to prevent an existing ephemeral drainage from becoming a perennial drainage due to development occurring in the watershed.

Of particular concern is the introduction of urban runoff pollutants into the ephemeral tributaries that traverse the project area and, indirectly, into the aquifer (Mehrten formation) that underlies the project area. Winter time discharge to these natural drainage courses will first be treated in the water quality treatment feature located in each of the project detention basins. These winter time flows will undergo treatment for removal of pollutants prior to discharge. Further, summer nuisance flows, which typically contain high nutrient concentrations, will be captured and retained on site and not discharged to the natural surface drainage courses. Accordingly, the likelihood of urban runoff pollutants infiltrating into the aquifer will be minimized.

In addition to storm water quality treatment features in each detention basin, Cordova Hills proposes to retain summer time nuisance flows on-site through the use of on-site percolation features. The objective of retaining summer time flows on-site is to minimize the chance of ephemeral to perennial conversion of natural drainage courses and minimize the likelihood of urban runoff pollutants entering the Mehrten formation that underlies the project area.

Strategies to accomplish on-site percolation will include one or more of the following approaches:

1. Installation of drainage facilities in areas of the project that don't have high groundwater recharge potential,
2. Installation of percolation trenches in project detention basins,
3. Installation of percolation chambers disbursed throughout the drainage collection system, and
4. The use of LID measures to capture and retain runoff throughout the project.

As part of the ongoing General Plan Update process, the County has identified the streambed of the tributary to Deer Creek that runs through the project area in a north-south direction as a "high groundwater recharge" zone. Except for the three roadway and one bike trail crossings of this stream, the development of Cordova Hills, and all drainage facilities associated therewith, do not encroach into this area.

Percolation within the project detention basins is also proposed. These basins will contain specially designed percolation trenches that will capture and infiltrate summer nuisance flows generated within each of the drainage watersheds of the project. **Table 5: Percolation Trenches** contains an evaluation of the number of percolation trenches that will be required for the project.

**Table 5: Percolation Trenches**

| Watershed | *equation* | Upper Laguna Creek | Unnamed Deer Creek | Carson Creek |
|---|---|---|---|---|
| Total Shed Area (acre) | *a* | 637.0 | 1,366.3 | 664.7 |
| Natural Preserve Area (acre) | *b* | 311.2 | 134.3 | 36.0 |
| Recreation 2 Area (acre) | *c* | 0.0 | 83.6 | 19.3 |
| Net Developable Area (acre) | *d = a - (b + c)* | 325.8 | 1,148.4 | 609.4 |
| No. of Basins | *e* | 5 | 15 | 7 |
| Average Development Area per Basin (acre) | *f = d / e* | 65.2 | 76.6 | 87.1 |
| Dry Season Flow per Average Basin (gpd) | *g = f * 0.001525 [1] * 43,560 * 7.48* | 32,377.3 | 38,041.8 | 43,257.7 |
| No. of Percolation Trenches Required | *h = g / 8,976* | 4 | 5 | 5 |

Notes:

[1] Stormwater Quality Design Manual for the Sacramento and South Placer Regions, dated May 2007, Table DB-2 Dry Weather Design Flows, Residential Basins 34, 63, 69, 132, average flow, page DB-8.

[2] Assume Percolation Rate below hardpan layer of 1-inch per hour (24 inches per day) - (personal conversation on 03/10/11 with Dennis Nakamoto, Senior Hydrologist, Wallace Kuhl & Associates).

[3] Assume three foot wide by 200-foot long Percolation Trench

[4] Percolation Volume / trench / day = (3-ft * 200-ft * 24-inches per day / 12-inches per ft) * 7.48 gallons per cubic foot = 8,976 gpd

Key:

gpm = gallon per minute

ft = foot

Table 5 demonstrates the average number of percolation trenches within each project detention basin so that summer nuisance flows can be mitigated. During the design of future small lot tentative maps and non-residential development applications more detailed calculations will be developed to demonstrate the ability of percolation trenches within project detention basins to capture and retain summer nuisance flows.

Refer to **Exhibit K: Conceptual Extended Duration Detention Basin Plan** to review a plan view of the typical Project detention basin. Refer to **Exhibit L: Conceptual Extended Duration Detention Basin Cross-Section** to review a cross section view of a typical Project detention basin.

Another, perhaps alternative, strategy that is being proposed is to install percolation chambers with each drainage inlet built in the development areas within the project. These chambers would be designed to capture summer nuisance flows that enter each drainage basin and infiltrate them instead of allow these flows to be discharged into the drainage collection system leading to the project detention basins. The design of these chambers would be included with the design of future small lot tentative maps and non-residential development applications.

Further, as the County perfects its LID design standards, various LID features will be incorporated into the on-site design of the project, as applicable, when small lot tentative maps and non-residential development applications are submitted for review and approval by the County. Design of applicable LID features will be included in the design of future small lot tentative maps and non-residential development applications.

## 3.5 Trunk Drainage Pipe System

The County of Sacramento Department of Water Resources defines trunk drainage facilities, incl. pipe systems as those facilities designed to convey runoff from a tributary shed area equal to or greater than 30 acres. Pipe systems are designed based on "Nolte flows", where "Nolte flows" equate to runoff equal to approximately 0.3 cubic feet per second /acre of residential development and 0.5 cubic feet/acre of commercial development.

Public utilities, including public storm drainage pipe systems are required to be accessible for maintenance purposes and as such, to be located within the public right-of-way. When they have to be aligned outside the public right-of-way, they have to be located within public storm drainage easements. The current entitlements being sought for the Cordova Hills SPA does not include small-lot tentative subdivision maps and associated subdivision street layouts. The smaller diameter collection pipe system that will collect and convey runoff within individual subdivisions towards the trunk drainage system is therefore not a part of this master plan level of analysis and will therefore have to be studied in detail as part of the small-lot subdivision map entitlement process. The larger trunk drainage pipes that collect and convey the runoff from the smaller collection system toward the detention basins and onward into the open receiving waters has been schematically aligned within the major streets depicted on the current land use plan. The resulting layout is depicted on **Exhibit R: Trunk Drainage Pipe System**. The "Nolte flows" runoff and hydraulic design calculations the trunk drainage pipe system is based on are located **in Appendix K: Trunk Drainage Pipe System – Hydraulic Analysis**.

# 4.0 Conclusion

The 2,668+/- acre Cordova Hills SPA is a proposed mixed-use community located within the Sacramento County Grant Line East Planning Area. The Project consists of low to high-density single-family residential, multi-family residential units, retail, mixed-use areas, schools (including the proposed private University of Sacramento campus), parks, open spaces, and community facilities.

This Drainage Master Plan for the Project analyzes drainage impacts resulting from development of the proposed land uses depicted in Exhibit B. The analysis defines how the proposed development can occur in a responsible and safe manner consistent with all applicable standards and regulations and how potential impacts on existing receiving waters can be fully mitigated to existing or better than existing conditions.

The Project can develop as proposed by constructing on-site combination flood and flow duration control basins that mitigate for the developments impacts. These basins include a wet water quality basin below the discharge elevation of the detention and flow duration control discharge structures. Summer nuisance flows will be percolated into the ground through specially designed and constructed percolation boxes connected by small drainage pipes to pre-determined drainage inlets and/or through percolation trenches constructed in the bottom of the water quality basins. In combination with the wet water quality basin attenuation, summer nuisance flows will be prevented from entering the receiving waters. The impacts on the Upper Laguna, Deer, and Carson Creek watersheds due to hydromodification are mitigated through the incorporation of flow duration control into the proposed detention/water quality basins to meter out stormwater runoff to match undeveloped runoff rates for storms ranging from 25% of the 2-year storm up to and including the 10-year storm. Flood control via the detention basins reduces the developed Project's calculated stormwater runoff rates for the 10-year 24-hour storm and the 100-year 24-hour storms to less than the pre-development peak flow rates for the same design storms.

With the implementation of the drainage facilities identified in this report, the Project can develop without negatively impacting the pre-development runoff volume, stage, water quality, and hydromodification of the Upper Laguna, Deer, and Carson Creek watersheds.

# 5.0 References

County of Sacramento, “Hydrology Standards Volume 2 of the Sacramento City/ County Drainage Manual,” December 1996.

County of Sacramento, “Stormwater Quality Design Manual for the Sacramento and South Placer Regions,” May 2007,

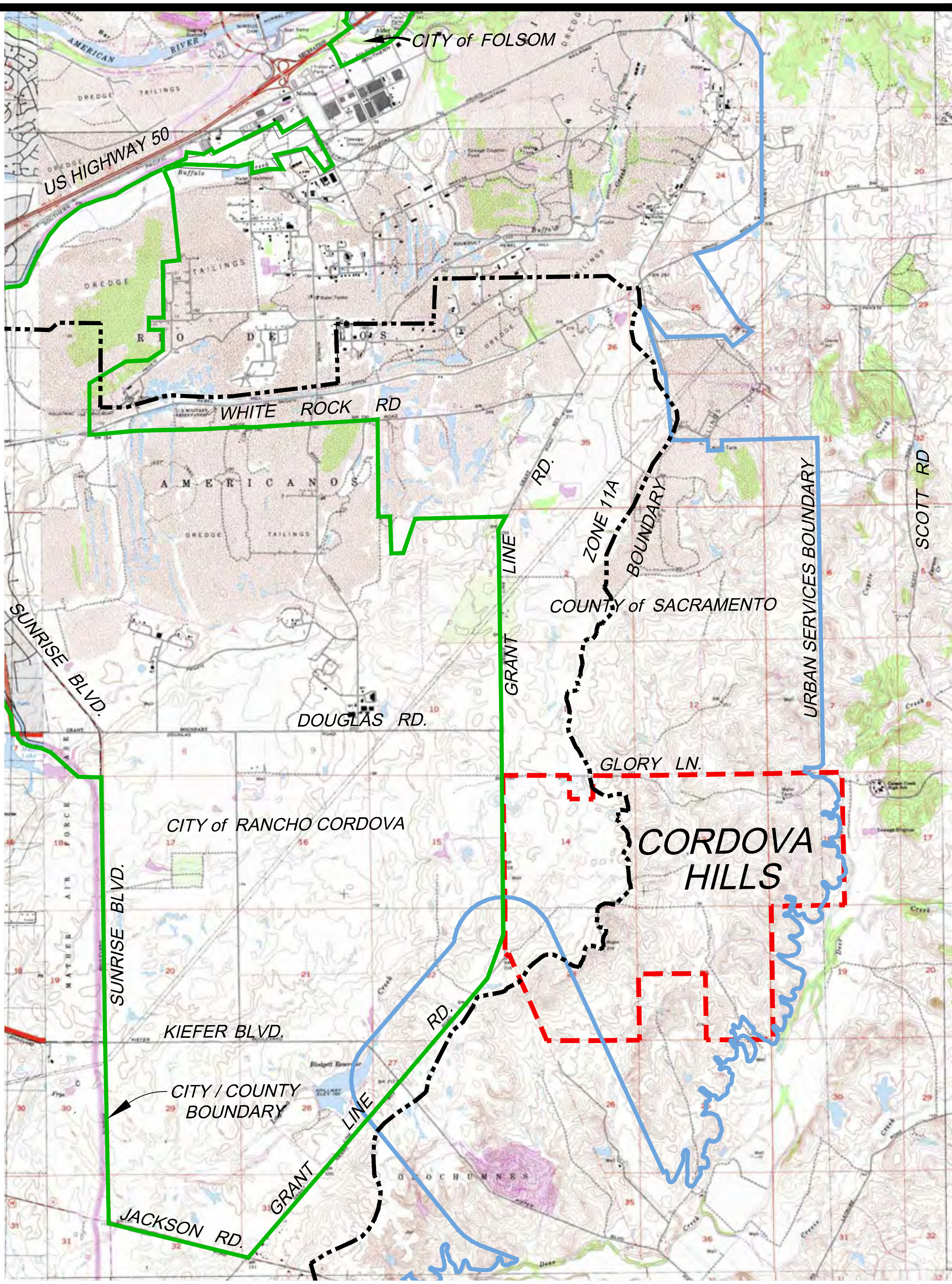
MacKay & Somps Civil Engineers, Inc., “DRAFT Regional Master Drainage Study for Sun Creek Specific Plan,” December 2008

Spink Corporation, “Final Master Drainage Study, Sunrise Douglas Community Plan Area, Sacramento, California,” October 16, 1998, (SDCPA Study).

Wood Rodgers, Inc., “Drainage Study Montelena Including Sections for Anatolia 1 & 2 Updated Ultimate Conditions and As-Built Facilities Summary,” September 2007.

Geosyntec Consultants, “A Technical Study of Hydrology, Geomorphology & Water Quality in the Laguna Creek Watershed,” November 2007.

# 6.0 Exhibits




**MACKAY & SOMPS**
CIVIL ENGINEERS, INC.
ROSEVILLE, CALIFORNIA (916) 773-1189

EXHIBIT A
Vicinity Map

# Cordova Hills SPA

County of Sacramento, California
Scale: N.T.S. March, 2011

7968-10

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There are no xreferences in this drawing.

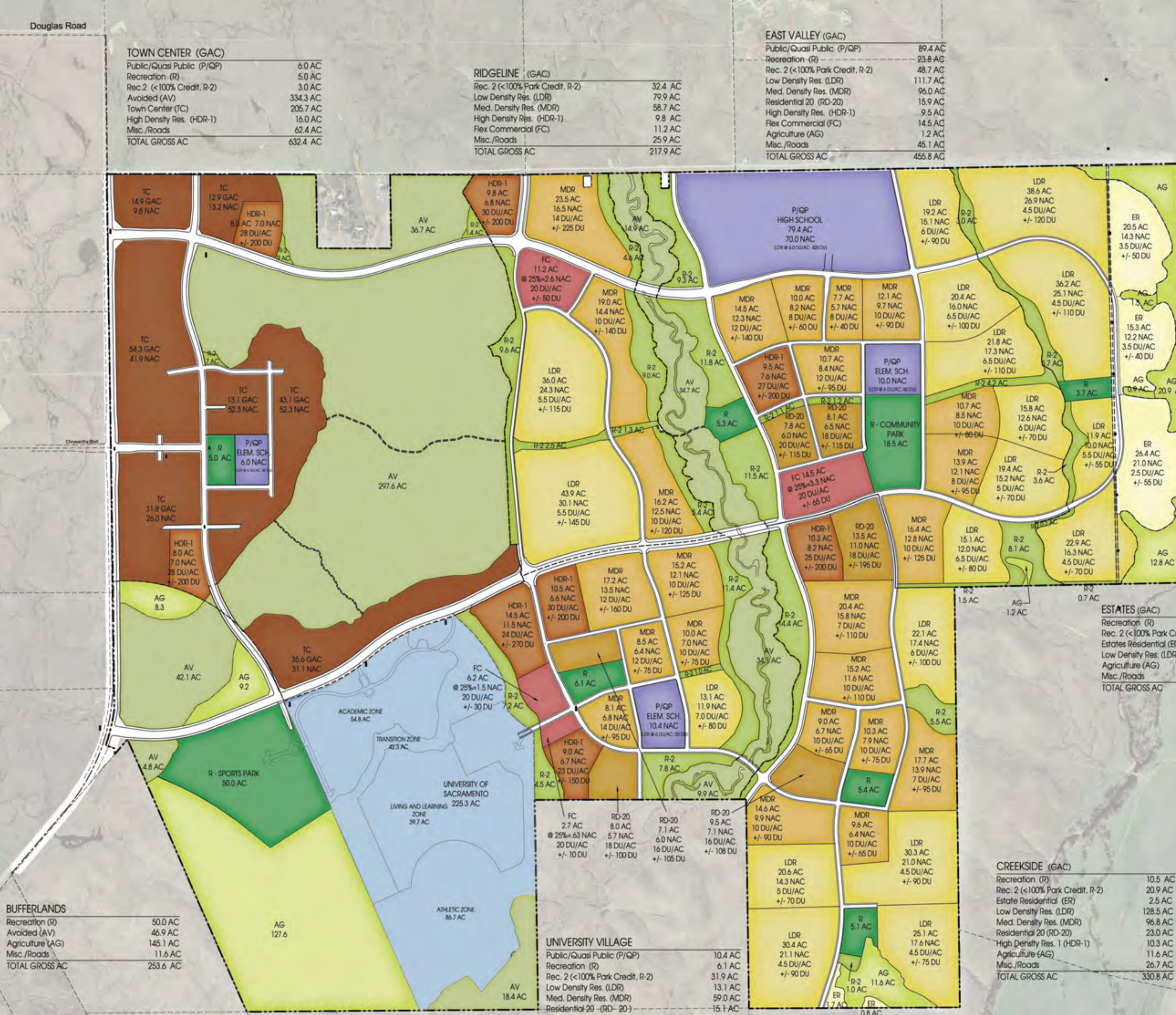
# Cordova Hills

# LAND USE PLAN

| TOWN CENTER (GAC) | |
|---|---|
| Public/Quasi Public (P/QP) | 6.0 AC |
| Recreation (R) | 5.0 AC |
| Rec.2 (<100% Credit, R-2) | 3.0 AC |
| Avoided (AV) | 334.3 AC |
| Town Center (TC) | 205.7 AC |
| High Density Res. (HDR-1) | 16.0 AC |
| Misc./Roads | 62.4 AC |
| TOTAL GROSS AC | 632.4 AC |

| RIDGELINE (GAC) | |
|---|---|
| Rec. 2 (<100% Park Credit, R-2) | 32.4 AC |
| Low Density Res. (LDR) | 79.9 AC |
| Med. Density Res. (MDR) | 58.7 AC |
| High Density Res. (HDR-1) | 9.8 AC |
| Flex Commercial (FC) | 11.2 AC |
| Misc./Roads | 25.9 AC |
| TOTAL GROSS AC | 217.9 AC |

| EAST VALLEY (GAC) | |
|---|---|
| Public/Quasi Public (P/QP) | 89.4 AC |
| Recreation (R) | 23.8 AC |
| Rec. 2 (<100% Park Credit, R-2) | 48.7 AC |
| Low Density Res. (LDR) | 111.7 AC |
| Med. Density Res. (MDR) | 96.0 AC |
| Residential 20 (RD-20) | 15.9 AC |
| High Density Res. (HDR-1) | 9.5 AC |
| Flex Commercial (FC) | 14.5 AC |
| Agriculture (AG) | 1.2 AC |
| Misc./Roads | 45.1 AC |
| TOTAL GROSS AC | 455.8 AC |




| ESTATES (GAC) | |
|---|---|
| Recreation (R) | 3.7 AC |
| Rec. 2 (<100% Park Credit, R-2) | 13.7 AC |
| Estates Residential (ER) | 62.2 AC |
| Low Density Res. (LDR) | 109.6 AC |
| Agriculture (AG) | 36.1 AC |
| Misc./Roads | 11.4 AC |
| TOTAL GROSS AC | 236.7 AC |

| CREEKSIDE (GAC) | |
|---|---|
| Recreation (R) | 10.5 AC |
| Rec. 2 (<100% Park Credit, R-2) | 20.9 AC |
| Estate Residential (ER) | 2.5 AC |
| Low Density Res. (LDR) | 128.5 AC |
| Med. Density Res. (MDR) | 96.8 AC |
| Residential 20 (RD-20) | 23.0 AC |
| High Density Res. 1 (HDR-1) | 10.3 AC |
| Agriculture (AG) | 11.6 AC |
| Misc./Roads | 26.7 AC |
| TOTAL GROSS AC | 330.8 AC |

| BUFFERLANDS | |
|---|---|
| Recreation (R) | 50.0 AC |
| Avoided (AV) | 46.9 AC |
| Agriculture (AG) | 145.1 AC |
| Misc./Roads | 11.6 AC |
| TOTAL GROSS AC | 253.6 AC |

| UNIVERSITY VILLAGE | |
|---|---|
| Public/Quasi Public (P/QP) | 10.4 AC |
| Recreation (R) | 6.1 AC |
| Rec. 2 (<100% Park Credit, R-2) | 31.9 AC |
| Low Density Res. (LDR) | 13.1 AC |
| Med. Density Res. (MDR) | 59.0 AC |
| Residential 20 (RD- 20) | 15.1 AC |
| High Density Res. 1 (HDR-1) | 34.0 AC |
| Flex Commercial (FC) | 8.9 AC |
| Misc./Roads | 23.6 AC |
| TOTAL GROSS AC | 202.1 AC |

## CORDOVA HILLS LAND USE SUMMARY

| | |
|---|---|
| PUBLIC/QUASI PUBLIC (P/QP) | 105.8 AC |
| RECREATION (R) | 99.1 AC |
| REC. 2 (<100% PARK CREDIT, R-2) | 150.6 AC |
| AVOIDED (AV) | 493.2 AC |
| ESTATES RES. (ER) 1 - 4 DU/AC | 64.7 AC |
| LOW DENSITY RES. (LDR) 4 - 7 DU/AC | 442.8 AC |
| MED. DENSITY RES. (MDR) 7 - 15 DU/AC | 310.5 AC |
| RESIDENTIAL - 20. (RD-20) 15 - 23 DU/AC | 54.0 AC |
| HIGH DENSITY RES. 1 (HDR-1) 23 - 30 DU/AC | 79.6 AC |
| FLEX COMMERCIAL (FC) | 34.6 AC |
| TOWN CENTER (TC) | 205.7 AC |
| UNIVERSITY OF SACRAMENTO | 223.5 AC |
| AGRICULTURE (AG) | 194.0 AC |
| MISC ROADS & OPEN SPACE | 210.4 AC |
| TOTAL GROSS ACREAGE | 2,668.5 AC |

# EXHIBIT 'B'

*Land Use Plan*

# *Cordova Hills SPA*

*County of Sacramento, California*

*Scale: N/A March, 2011*

Note: Exact Avoidance line to be determined by ECORP. This is for illustration purposes only.



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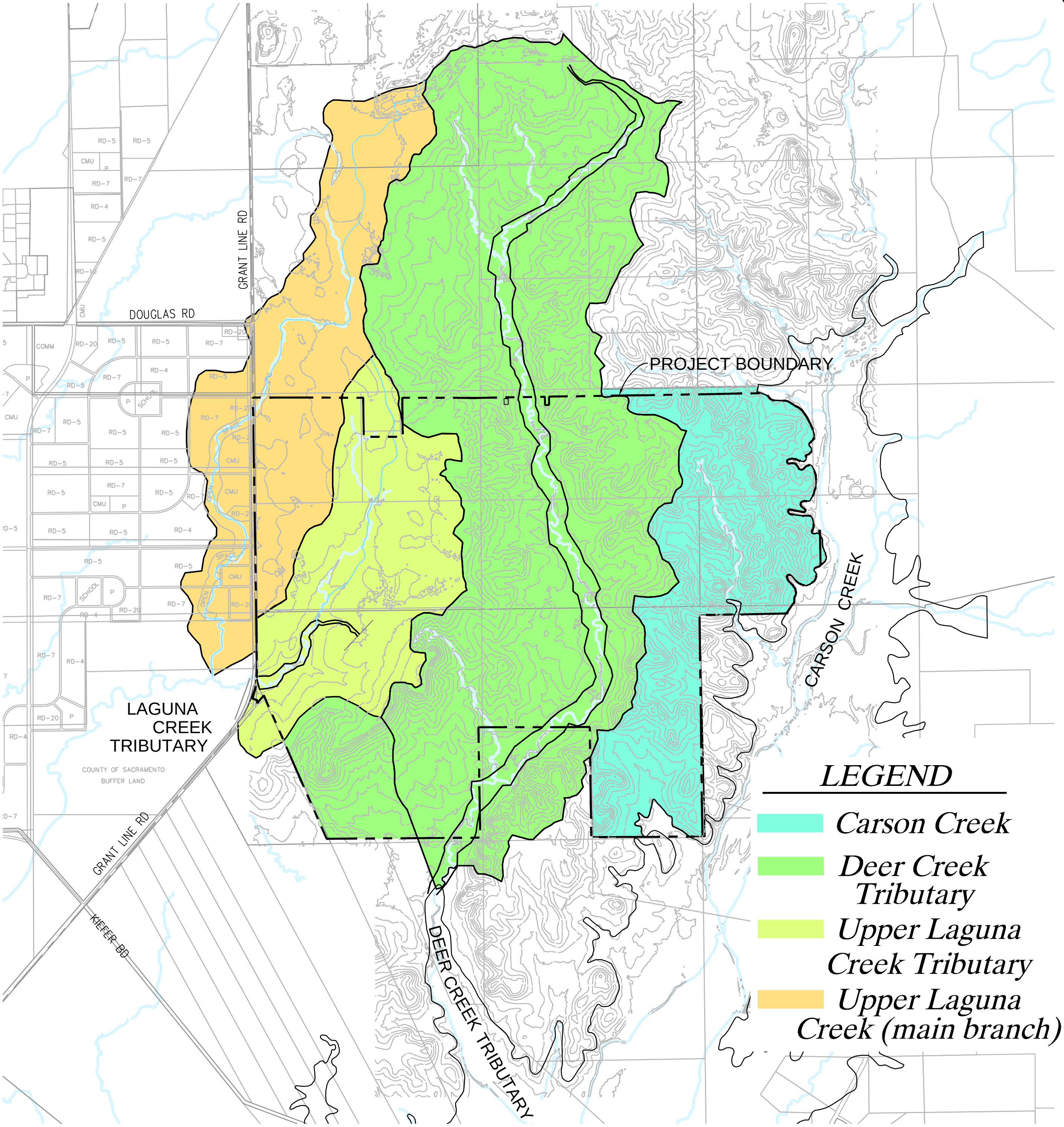
There are no xreferences in this drawing.




# EXHIBIT C

## Drainage Study Area Map

# Cordova Hills SPA

County of Sacramento, California

Scale: N.T.S. May, 2011

7968-10

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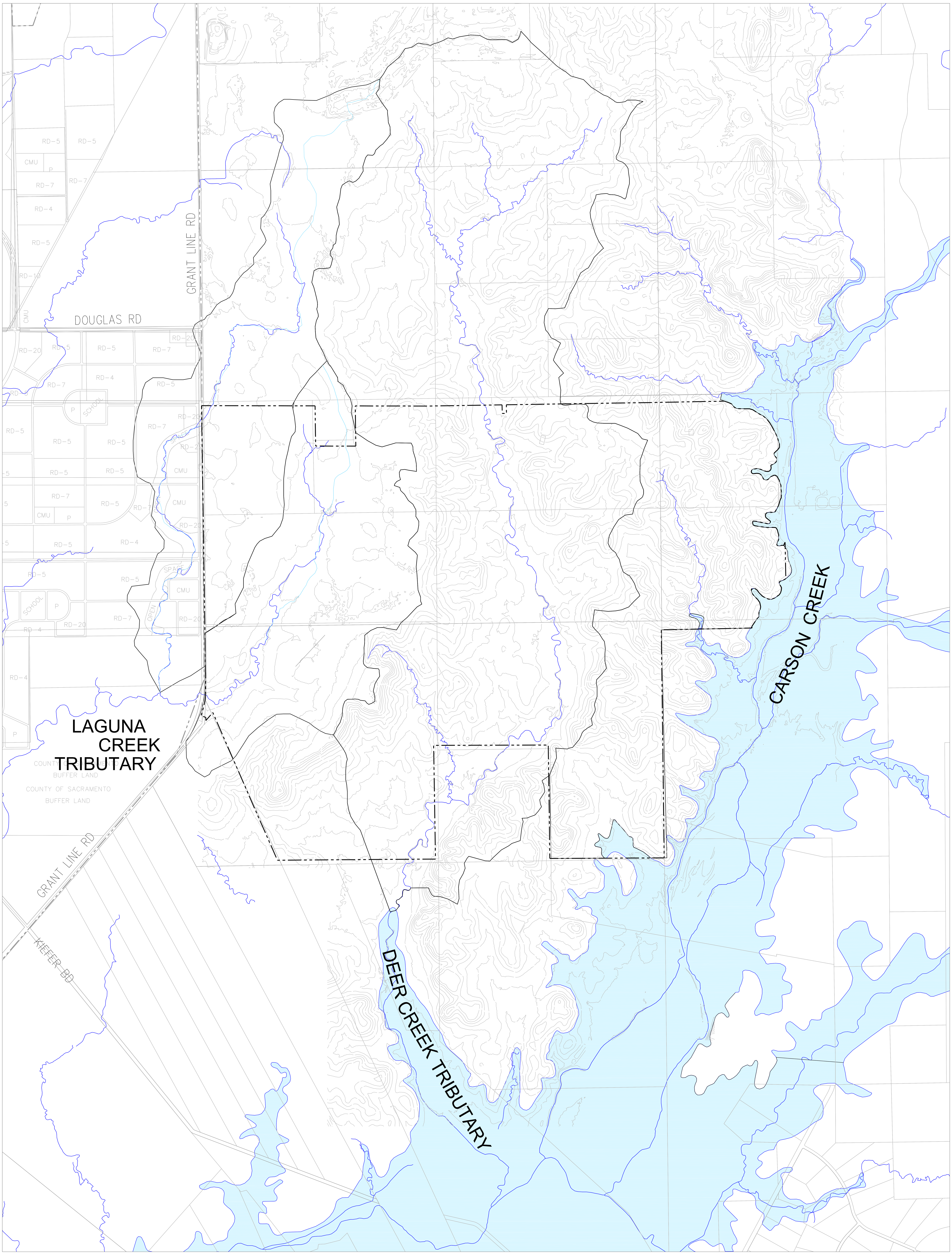
There are no xreferences in this drawing.




0 500 1000 2000
SCALE: 1"=1000'

*100-Year Flood Plain*

*Carson Creek (Zone A)*

*(FIRM Panel Number: 060262 0250 C)*

*EXHIBIT D*
*CARSON CREEK*
*Extent of FEMA Mapped*
*Existing Condition Flood Plain*

# Cordova Hills SPA

County of Sacramento, California

Scale: 1" = 1000'

March, 2011

7968-10

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ROSEVILLE, CALIFORNIA (916) 773-1189


# Developed Conditions Deer Creek Tributary 100 Year Flood Plain

# Cordova Hills SPA

*Sacramento County, California*

*Sheet 1 of 2*

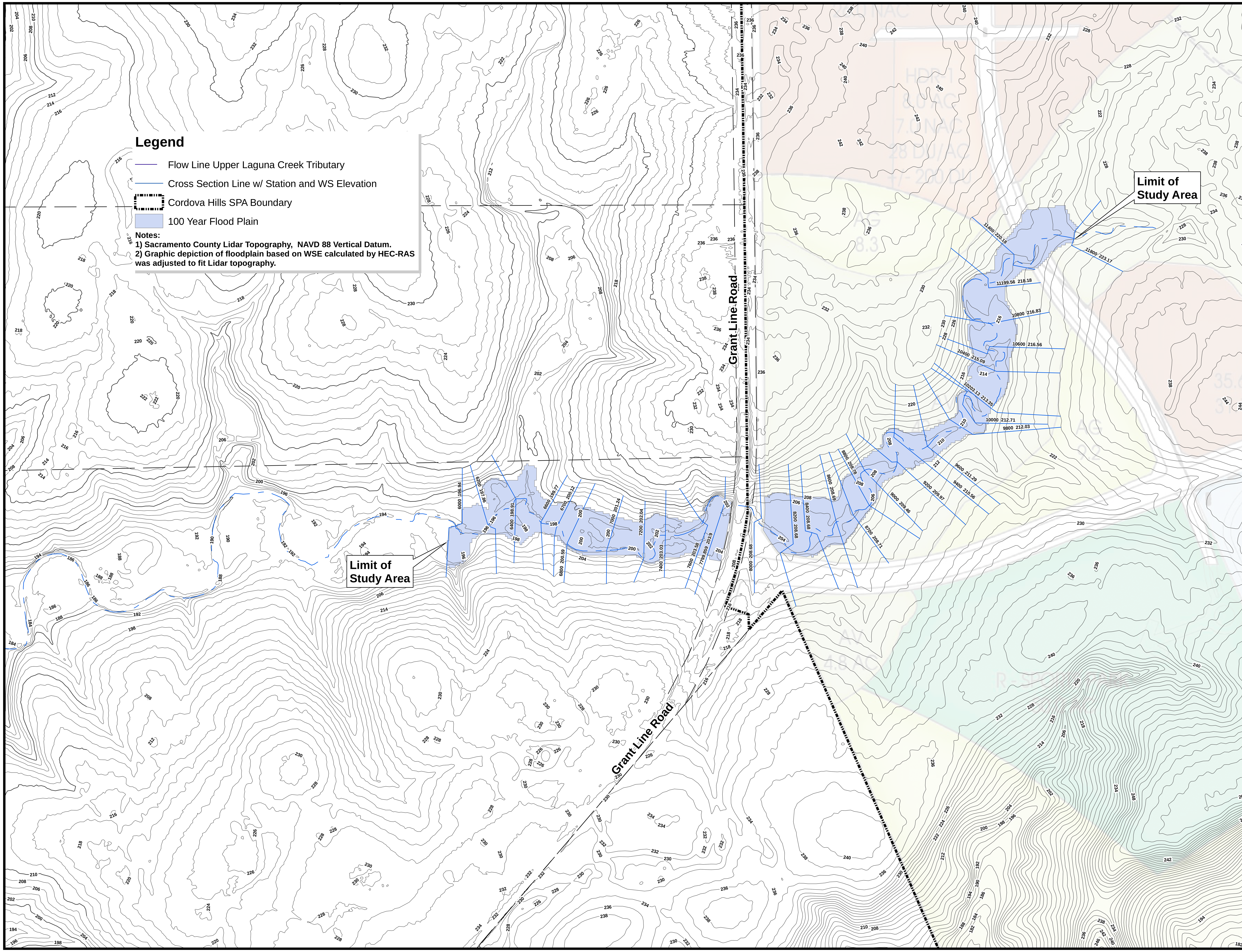
MacKAY & SOMPS
ENGINEERS PLANNERS SURVEYORS

1552 Eureka Road, Suite 100, Roseville CA

Job No: 7968.10 Date:05/26/2011


**Developed Conditions**
**Deer Creek Tributary**
**100 Year Flood Plain**
**Cordova Hills SPA**
Sacramento County, California
Sheet 2 of 2

MACKAY & SOMPS
ENGINEERS PLANNERS SURVEYORS
1552 Eureka Road, Suite 100, Roseville CA
Job No: 7968.10 Date:05/26/2011

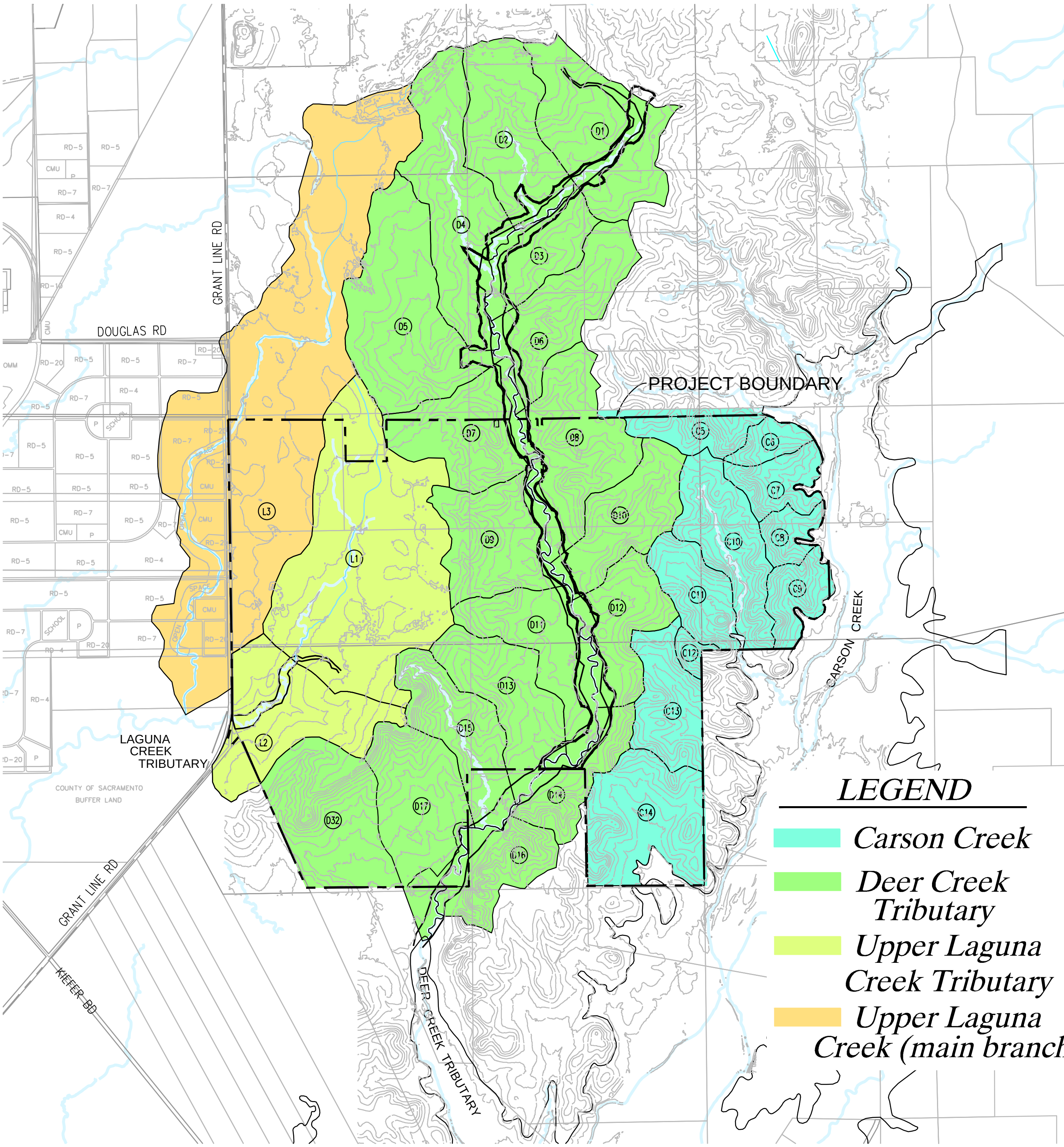



**Developed Conditions**
**Upper Laguna Creek Tributary**
**100 Year Flood Plain**

# Cordova Hills SPA

*Sacramento County, California*

MACKAY & SOMPS
ENGINEERS PLANNERS SURVEYORS
1552 Eureka Road, Suite 100, Roseville CA
Job No: 7968.10 Date:05/26/2011




# EXHIBIT F
## Pre-Development Watershed Map

# Cordova Hills SPA

County of Sacramento, California

Scale: N.T.S. March, 2011

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7968-10

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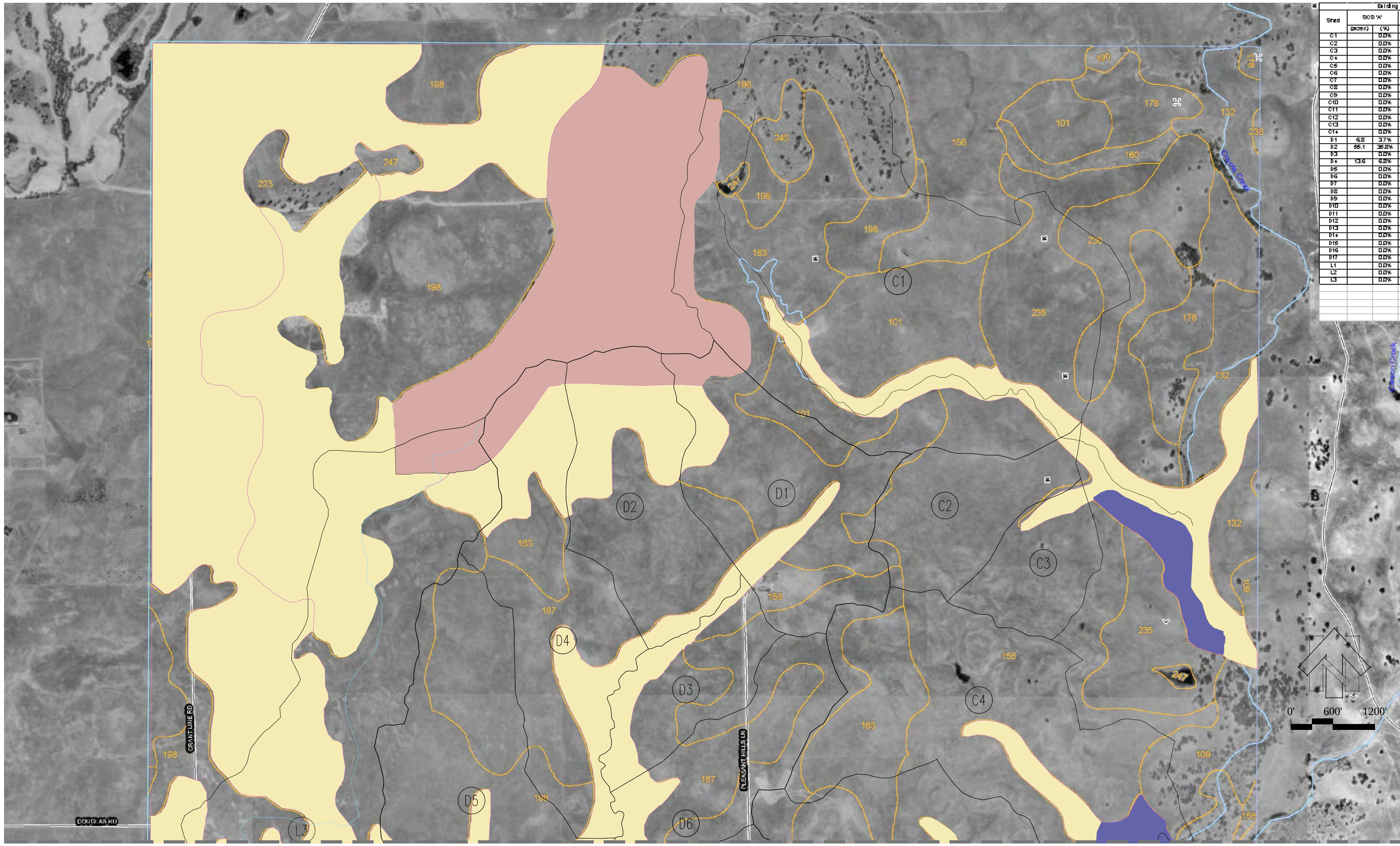
There are no xreferences in this drawing.

| Existing Drainage Sheds - Composite SCS Analysis | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Shed | SCS 'A' | | SCS 'B' | | SCS 'C' | | SCS 'D' | | Total Acres |
| | (acres) | (%) | (acres) | (%) | (acres) | (%) | (acres) | (%) | (acres) |
| C1 | | 0.0% | | 0.0% | 19 | 22.8% | 64.4 | 77.2% | 83.4 |
| C2 | | 0.0% | | 0.0% | 6 | 5.9% | 95.5 | 94.1% | 101.5 |
| C3 | | 0.0% | | 0.0% | 13.9 | 19.9% | 55.9 | 80.1% | 69.8 |
| C4 | | 0.0% | 12.1 | 4.2% | 19 | 6.6% | 257.3 | 89.2% | 288.4 |
| C5 | | 0.0% | | 0.0% | 26 | 10.3% | 226.4 | 89.7% | 252.4 |
| C6 | | 0.0% | | 0.0% | | 0.0% | 30 | 100.0% | 30 |
| C7 | | 0.0% | | 0.0% | | 0.0% | 52.7 | 100.0% | 52.7 |
| C8 | | 0.0% | | 0.0% | | 0.0% | 31 | 100.0% | 31 |
| C9 | | 0.0% | | 0.0% | | 0.0% | 49.7 | 100.0% | 49.7 |
| C10 | | 0.0% | | 0.0% | | 0.0% | 118.6 | 100.0% | 118.6 |
| C11 | | 0.0% | | 0.0% | | 0.0% | 72.3 | 100.0% | 72.3 |
| C12 | | 0.0% | | 0.0% | | 0.0% | 12.2 | 100.0% | 12.2 |
| C13 | | 0.0% | | 0.0% | 12 | 9.8% | 110.4 | 90.2% | 122.4 |
| C14 | | 0.0% | | 0.0% | | 0.0% | 155.9 | 100.0% | 155.9 |
| D1 | 6.8 | 3.7% | | 0.0% | 23.7 | 12.9% | 152.6 | 83.3% | 183.1 |
| D2 | 55.1 | 35.8% | | 0.0% | 60.6 | 39.4% | 38.3 | 24.9% | 154 |
| D3 | | 0.0% | | 0.0% | 18.8 | 23.0% | 62.9 | 77.0% | 81.7 |
| D4 | 13.6 | 6.8% | | 0.0% | 68.4 | 34.3% | 117.2 | 58.8% | 199.2 |
| D5 | | 0.0% | | 0.0% | 42.1 | 18.5% | 185.3 | 81.5% | 227.4 |
| D6 | | 0.0% | | 0.0% | 21.3 | 16.7% | 106.5 | 83.3% | 127.8 |
| D7 | | 0.0% | 2 | 1.5% | 48.8 | 36.6% | 82.6 | 61.9% | 133.4 |
| D8 | | 0.0% | 17.3 | 10.6% | 15.9 | 9.8% | 129.7 | 79.6% | 162.9 |
| D9 | | 0.0% | 9.6 | 7.2% | 1.6 | 1.2% | 122.5 | 91.6% | 133.7 |
| D10 | | 0.0% | 11.8 | 10.4% | 8.6 | 7.5% | 93.6 | 82.1% | 114 |
| D11 | | 0.0% | 12.3 | 9.8% | 9.7 | 7.8% | 103 | 82.4% | 125 |
| D12 | | 0.0% | 35 | 33.6% | | 0.0% | 69.3 | 66.4% | 104.3 |
| D13 | | 0.0% | | 0.0% | 21.3 | 17.1% | 103.3 | 82.9% | 124.6 |
| D14 | | 0.0% | 3.7 | 4.8% | 8.3 | 10.8% | 65.2 | 84.5% | 77.2 |
| D15 | | 0.0% | | 0.0% | 9.5 | 8.1% | 108.2 | 91.9% | 117.7 |
| D16 | | 0.0% | | 0.0% | 7.4 | 8.1% | 83.5 | 91.9% | 90.9 |
| D17 | | 0.0% | | 0.0% | 4.6 | 2.9% | 156 | 97.1% | 160.6 |
| L1 | | 0.0% | | 0.0% | 177.8 | 40.8% | 258.2 | 59.2% | 436 |
| L2 | | 0.0% | | 0.0% | | 0.0% | 170 | 100.0% | 170 |
| L3 | | 0.0% | | 0.0% | 355.47 | 46.2% | 414.13 | 53.8% | 769.6 |




**LEGEND:**

- TYPE A SOIL
- TYPE B SOIL
- TYPE C SOIL
- TYPE D SOIL

MATCH LINE SEE SHEET 1

# EXHIBIT G

## PRE-DEVELOPMENT SOILS ANALYSIS (SCS)

# Cordova Hills SPA

*County of Sacramento, California*

*March, 2011* *Sheet 2 of 2*

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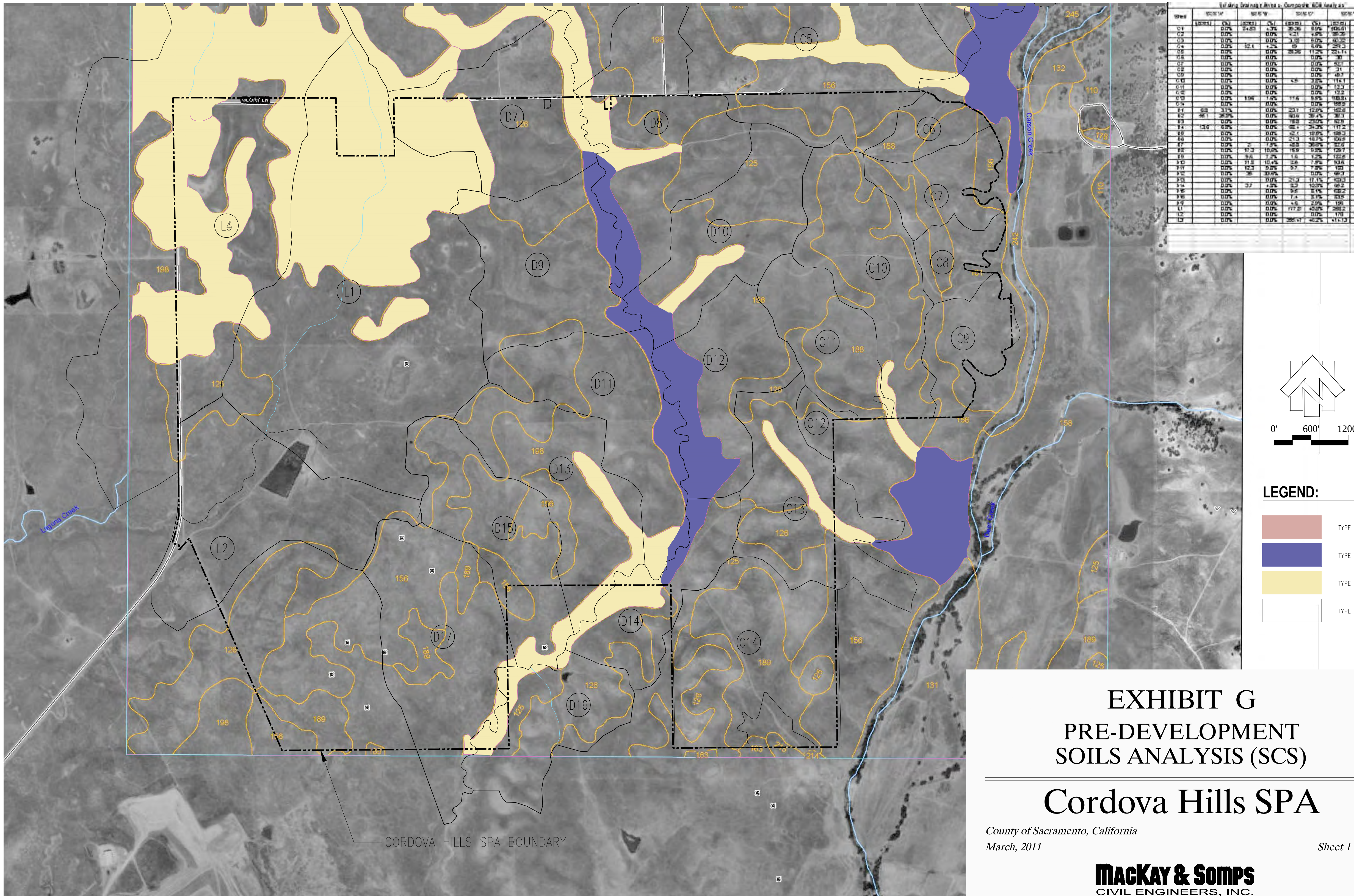
MATCH LINE SEE SHEET 2




Existing Drainage Sheds - Composite SCS Analysis

| Shed | SCS 'A' | | SCS 'B' | | SCS 'C' | | SCS 'D' | | Total Acres |
|---|---|---|---|---|---|---|---|---|---|
| | (acres) | (%) | (acres) | (%) | (acres) | (%) | (acres) | (%) | (acres) |
| C1 | | 0.0% | 24.53 | 4.3% | 39.36 | 6.9% | 506.61 | 88.8% | 570.5 |
| C2 | | 0.0% | | 0.0% | 4.21 | 4.5% | 89.39 | 95.5% | 93.6 |
| C3 | | 0.0% | | 0.0% | 3.18 | 5.0% | 60.32 | 95.0% | 63.5 |
| C4 | | 0.0% | 12.1 | 4.2% | 19 | 6.6% | 257.3 | 89.2% | 288.4 |
| C5 | | 0.0% | | 0.0% | 28.26 | 11.2% | 224.14 | 88.8% | 252.4 |
| C6 | | 0.0% | | 0.0% | | 0.0% | 30 | 100.0% | 30 |
| C7 | | 0.0% | | 0.0% | | 0.0% | 52.7 | 100.0% | 52.7 |
| C8 | | 0.0% | | 0.0% | | 0.0% | 31 | 100.0% | 31 |
| C9 | | 0.0% | | 0.0% | | 0.0% | 49.7 | 100.0% | 49.7 |
| C10 | | 0.0% | | 0.0% | 4.5 | 3.8% | 114.1 | 96.2% | 118.6 |
| C11 | | 0.0% | | 0.0% | | 0.0% | 72.3 | 100.0% | 72.3 |
| C12 | | 0.0% | | 0.0% | | 0.0% | 17.2 | 100.0% | 17.2 |
| C13 | | 0.0% | 1.96 | 1.6% | 11.6 | 9.5% | 108.84 | 88.9% | 122.4 |
| C14 | | 0.0% | | 0.0% | | 0.0% | 195.9 | 100.0% | 195.9 |
| D1 | 6.3 | 3.7% | | 0.0% | 23.7 | 12.9% | 152.8 | 83.3% | 183.1 |
| D2 | 55.1 | 35.8% | | 0.0% | 60.6 | 39.4% | 38.3 | 24.9% | 154 |
| D3 | | 0.0% | | 0.0% | 18.8 | 23.0% | 62.9 | 77.0% | 81.7 |
| D4 | 13.5 | 6.8% | | 0.0% | 68.4 | 34.3% | 117.2 | 58.8% | 199.2 |
| D5 | | 0.0% | | 0.0% | 42.1 | 18.5% | 185.3 | 81.5% | 227.4 |
| D6 | | 0.0% | | 0.0% | 21.3 | 16.7% | 106.5 | 83.3% | 127.8 |
| D7 | | 0.0% | 2 | 1.5% | 48.8 | 36.6% | 82.6 | 61.9% | 133.4 |
| D8 | | 0.0% | 17.3 | 10.6% | 15.9 | 9.8% | 129.7 | 79.6% | 162.9 |
| D9 | | 0.0% | 9.6 | 7.2% | 1.6 | 1.2% | 122.5 | 91.6% | 133.7 |
| D10 | | 0.0% | 11.9 | 10.4% | 8.6 | 7.5% | 93.6 | 82.1% | 114 |
| D11 | | 0.0% | 12.3 | 9.8% | 9.7 | 7.8% | 103 | 82.4% | 125 |
| D12 | | 0.0% | 35 | 33.6% | | 0.0% | 69.3 | 66.4% | 104.3 |
| D13 | | 0.0% | | 0.0% | 21.3 | 17.1% | 103.3 | 82.9% | 124.6 |
| D14 | | 0.0% | 3.7 | 4.8% | 8.3 | 10.8% | 65.2 | 84.5% | 77.2 |
| D15 | | 0.0% | | 0.0% | 9.5 | 8.1% | 108.2 | 91.9% | 117.7 |
| D16 | | 0.0% | | 0.0% | 7.4 | 8.1% | 83.5 | 91.9% | 90.9 |
| D17 | | 0.0% | | 0.0% | 4.6 | 2.9% | 156 | 97.1% | 160.6 |
| L1 | | 0.0% | | 0.0% | 177.8 | 40.8% | 258.2 | 59.2% | 436 |
| L2 | | 0.0% | | 0.0% | | 0.0% | 170 | 100.0% | 170 |
| L3 | | 0.0% | | 0.0% | 365.47 | 46.2% | 414.13 | 53.8% | 779.6 |

# EXHIBIT G

## PRE-DEVELOPMENT SOILS ANALYSIS (SCS)

# Cordova Hills SPA

*County of Sacramento, California*

*March, 2011* *Sheet 1 of 2*

MACKAY & SOMPS
CIVIL ENGINEERS, INC.
ROSEVILLE, CALIFORNIA (916) 773-1189

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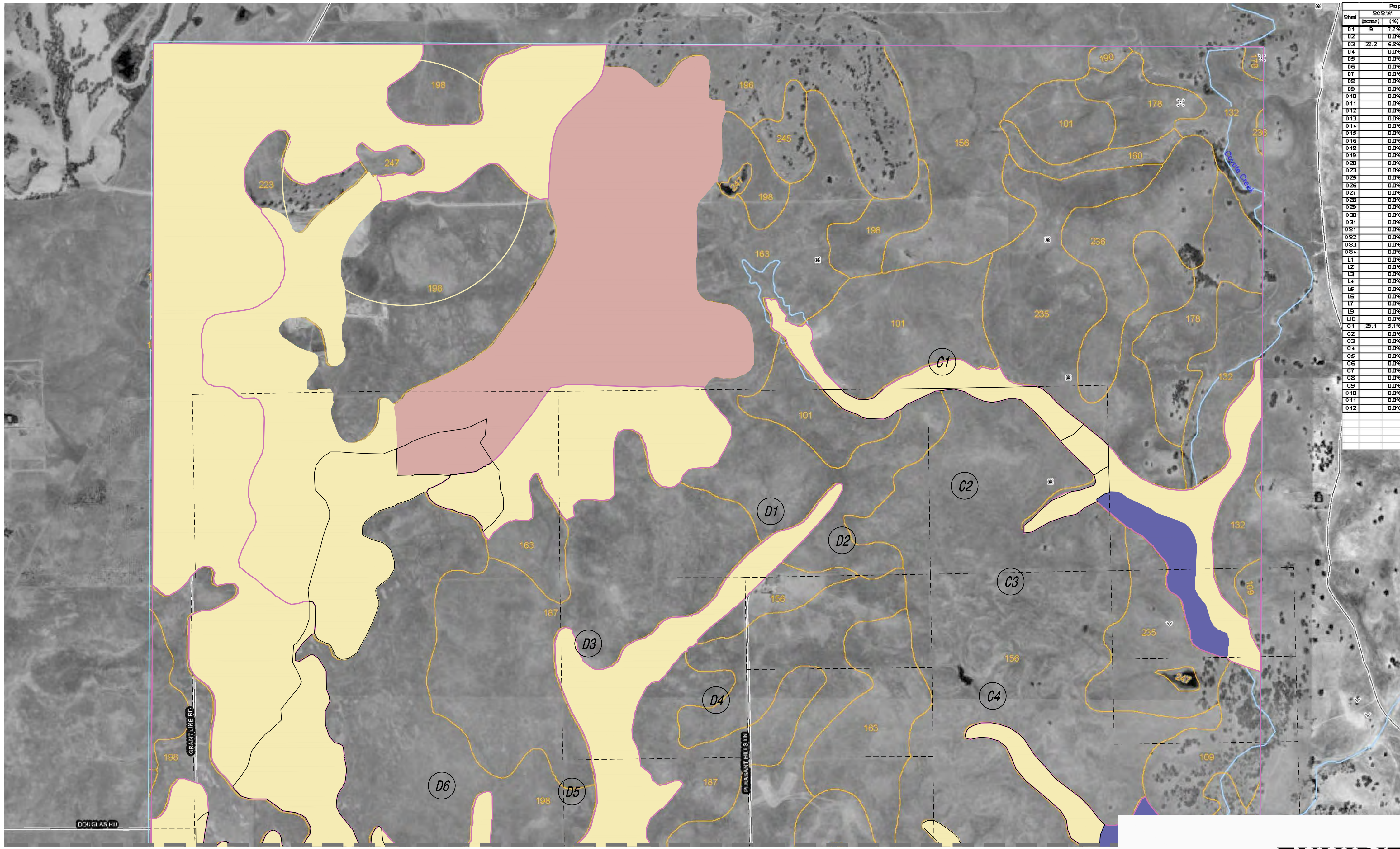
03-11-2011 3:41pm Mike Jones P:\7968\MASTER PLANS\CH-SDMP\EXHIBITS\EXHIBIT G - PRE DEVELOPMENT SOILS ANALYSIS.DWG

| Proposed Drainage Sheds - Composite SCS Analysis | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Shed | SCS 'A' | | SCS 'B' | | SCS 'C' | | SCS 'D' | | Total Acres |
| | (acres) | (%) | (acres) | (%) | (acres) | (%) | (acres) | (%) | (acres) |
| D1 | 9 | 7.7% | 3.7 | 3.1% | 27.2 | 23.1% | 77.6 | 66.0% | 117.5 |
| D2 | | 0.0% | 3.3 | 2.1% | 11.8 | 7.6% | 141.1 | 90.3% | 156.2 |
| D3 | 22.2 | 6.8% | | 0.0% | 108.2 | 33.3% | 194.7 | 59.9% | 325.1 |
| D4 | | 0.0% | | 0.0% | 35.6 | 24.8% | 108.2 | 75.2% | 143.8 |
| D5 | | 0.0% | | 0.0% | 13.9 | 33.7% | 27.3 | 66.3% | 41.2 |
| D6 | | 0.0% | | 0.0% | 31.4 | 15.2% | 175.2 | 84.8% | 206.6 |
| D7 | | 0.0% | | 0.0% | 18.8 | 32.4% | 39.2 | 67.6% | 58 |
| D8 | | 0.0% | | 0.0% | 7.5 | 8.8% | 77.5 | 91.2% | 85 |
| D9 | | 0.0% | | 0.0% | 5.56 | 23.8% | 17.77 | 76.2% | 23.33 |
| D10 | | 0.0% | 1 | 2.4% | 5.49 | 13.2% | 35.09 | 84.4% | 41.58 |
| D11 | | 0.0% | 1.39 | 1.5% | 9.22 | 9.9% | 82.52 | 88.6% | 93.13 |
| D12 | | 0.0% | 1.18 | 1.6% | 2.02 | 2.7% | 71.99 | 95.7% | 75.19 |
| D13 | | 0.0% | 2.06 | 2.7% | | 0.0% | 75.03 | 97.3% | 77.09 |
| D14 | | 0.0% | | 0.0% | 1.24 | 3.5% | 34.21 | 96.5% | 35.45 |
| D15 | | 0.0% | 9.81 | 7.8% | 8.72 | 7.0% | 106.75 | 85.2% | 125.28 |
| D16 | | 0.0% | 0.55 | 1.2% | | 0.0% | 44.62 | 98.8% | 45.17 |
| D18 | | 0.0% | 2.21 | 5.4% | 0.01 | 0.0% | 38.49 | 94.5% | 40.71 |
| D19 | | 0.0% | 10.91 | 39.8% | 4.81 | 17.5% | 11.7 | 42.7% | 27.42 |
| D20 | | 0.0% | 0.12 | 0.4% | | 0.0% | 27.3 | 99.6% | 27.42 |
| D23 | | 0.0% | 0.31 | 1.6% | 5.63 | 28.5% | 13.84 | 70.0% | 19.78 |
| D25 | | 0.0% | 0.03 | 0.0% | 5.61 | 4.5% | 119.25 | 95.5% | 124.89 |
| D26 | | 0.0% | 0.04 | 0.1% | 15.32 | 29.1% | 37.28 | 70.8% | 52.64 |
| D27 | | 0.0% | | 0.0% | | 0.0% | 60.86 | 100.0% | 60.86 |
| D28 | | 0.0% | | 0.0% | 24.94 | 18.2% | 112.02 | 81.8% | 136.96 |
| D29 | | 0.0% | | 0.0% | | 0.0% | 31.42 | 100.0% | 31.42 |
| D30 | | 0.0% | | 0.0% | | 0.0% | 32.98 | 100.0% | 32.98 |
| D31 | | 0.0% | | 0.0% | | 0.0% | 64.31 | 100.0% | 64.31 |
| OS1 | | 0.0% | 3.9 | 26.4% | 10.65 | 72.1% | 0.22 | 1.5% | 14.77 |
| OS2 | | 0.0% | 29.99 | 77.0% | | 0.0% | 8.98 | 23.0% | 38.97 |
| OS3 | | 0.0% | 27.53 | 81.0% | | 0.0% | 6.45 | 19.0% | 33.98 |
| OS4 | | 0.0% | 1.18 | 12.4% | 7.89 | 82.7% | 0.47 | 4.9% | 9.54 |
| L1 | | 0.0% | | 0.0% | 67.82 | 100.0% | 0 | 0.0% | 67.82 |
| L2 | | 0.0% | | 0.0% | 106.42 | 35.8% | 190.92 | 64.2% | 297.34 |
| L3 | | 0.0% | | 0.0% | | 0.0% | 86.06 | 100.0% | 86.06 |
| L4 | | 0.0% | | 0.0% | 28.08 | 23.9% | 89.64 | 76.1% | 117.72 |
| L5 | | 0.0% | 16.9 | 4.7% | 212 | 59.0% | 130.4 | 36.3% | 359.3 |
| L6 | | 0.0% | | 0.0% | 33.34 | 61.4% | 20.92 | 38.6% | 54.26 |
| L7 | | 0.0% | | 0.0% | 53.36 | 61.0% | 34.09 | 39.0% | 87.45 |
| L9 | | 0.0% | | 0.0% | | 0.0% | 105.13 | 100.0% | 105.13 |
| L10 | | 0.0% | | 0.0% | 82.28 | 37.9% | 135.02 | 62.1% | 217.3 |
| C1 | 29.1 | 5.1% | | 0.0% | 38.6 | 6.8% | 501.8 | 88.1% | 569.5 |
| C2 | | 0.0% | | 0.0% | 4.4 | 5.9% | 70 | 94.1% | 74.4 |
| C3 | | 0.0% | | 0.0% | 5.7 | 9.0% | 57.8 | 91.0% | 63.5 |
| C4 | | 0.0% | 14.8 | 6.2% | 18.7 | 7.9% | 204.2 | 85.9% | 237.7 |
| C5 | | 0.0% | 0.6 | 0.3% | 21.2 | 10.3% | 184.5 | 89.4% | 206.3 |
| C6 | | 0.0% | | 0.0% | | 0.0% | 61.76 | 100.0% | 61.76 |
| C7 | | 0.0% | | 0.0% | | 0.0% | 53.19 | 100.0% | 53.19 |
| C8 | | 0.0% | | 0.0% | | 0.0% | 32.97 | 100.0% | 32.97 |
| C9 | | 0.0% | | 0.0% | | 0.0% | 47.45 | 100.0% | 47.45 |
| C10 | | 0.0% | | 0.0% | 4 | 2.3% | 170.5 | 97.7% | 174.5 |
| C11 | | 0.0% | | 0.0% | 8.66 | 10.9% | 70.57 | 89.1% | 79.23 |
| C12 | | 0.0% | | 0.0% | | 0.0% | 154.14 | 100.0% | 154.14 |




**LEGEND:**

- TYPE A SOIL
- TYPE B SOIL
- TYPE C SOIL
- TYPE D SOIL

MATCH LINE SEE SHEET 1

0' 600' 1200'

# EXHIBIT H

## POST-DEVELOPMENT SOILS ANALYSIS (SCS)

# Cordova Hills SPA

*County of Sacramento, California*

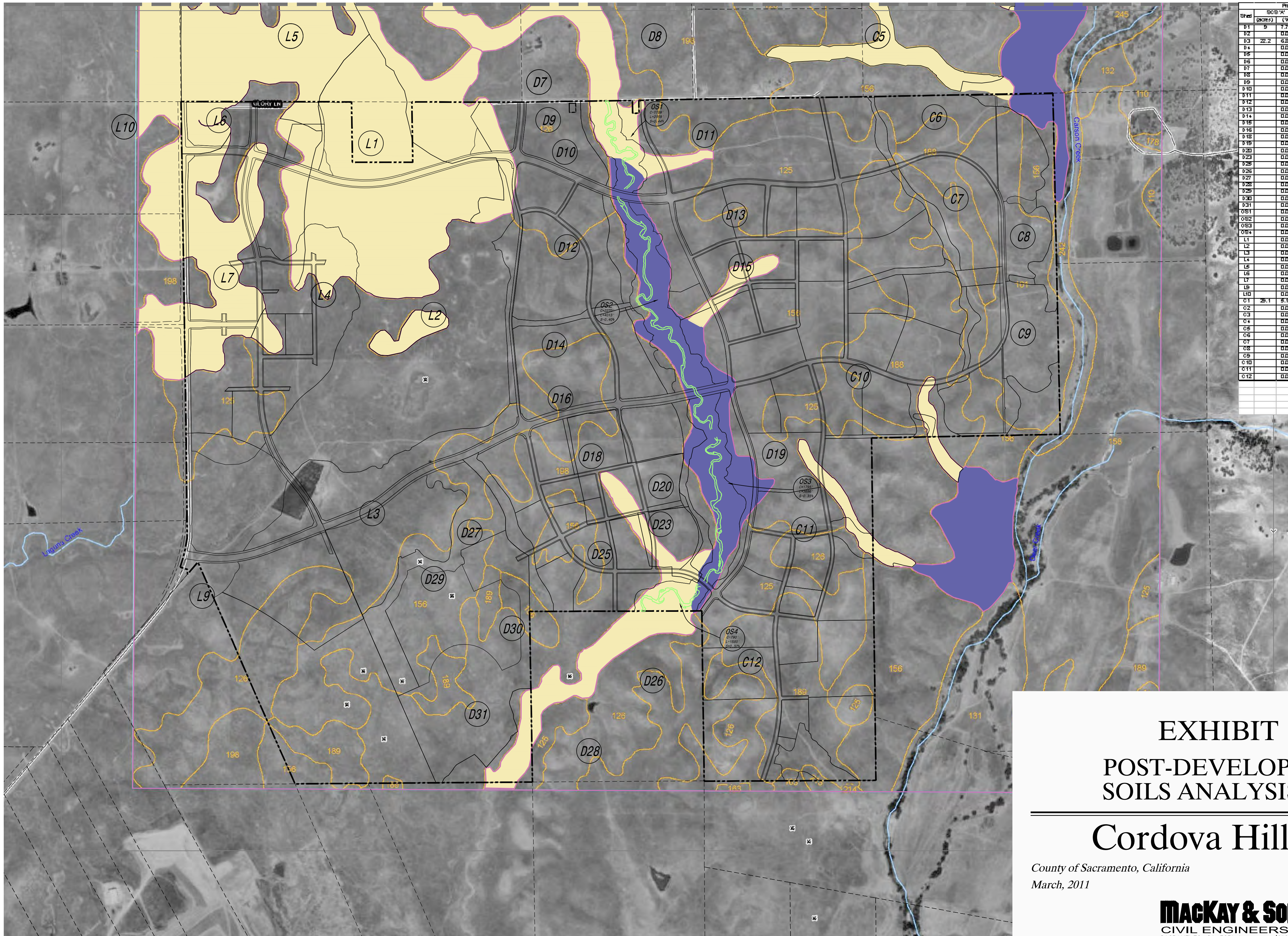
*March, 2011*



MACKAY & SOMPS
CIVIL ENGINEERS, INC.
SACRAMENTO, CALIFORNIA (916) 929-6092

7968-10

MATCH LINE SEE SHEET 2




| Proposed Drainage Sheds - Composite SCS Analysis | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Shed | SCS 'A' | | SCS 'B' | | SCS 'C' | | SCS 'D' | | Total Acres |
| | (acres) | (%) | (acres) | (%) | (acres) | (%) | (acres) | (%) | (acres) |
| D1 | 9 | 7.7% | 3.7 | 3.1% | 27.2 | 23.1% | 77.6 | 66.0% | 117.5 |
| D2 | | 0.0% | 3.3 | 2.1% | 11.8 | 7.6% | 141.1 | 90.3% | 156.2 |
| D3 | 22.2 | 6.8% | | 0.0% | 108.2 | 33.3% | 194.7 | 59.9% | 325.1 |
| D4 | | 0.0% | | 0.0% | 35.6 | 24.8% | 108.2 | 75.2% | 143.8 |
| D5 | | 0.0% | | 0.0% | 13.9 | 33.7% | 27.3 | 66.3% | 41.2 |
| D6 | | 0.0% | | 0.0% | 31.4 | 15.2% | 175.2 | 84.8% | 206.6 |
| D7 | | 0.0% | | 0.0% | 18.8 | 32.4% | 39.2 | 67.6% | 58 |
| D8 | | 0.0% | | 0.0% | 7.5 | 8.8% | 77.5 | 91.2% | 85 |
| D9 | | 0.0% | | 0.0% | 5.56 | 23.8% | 17.77 | 76.2% | 23.33 |
| D10 | | 0.0% | 1 | 2.4% | 5.49 | 13.2% | 35.09 | 84.4% | 41.58 |
| D11 | | 0.0% | 1.39 | 1.5% | 9.22 | 9.9% | 82.52 | 88.6% | 93.13 |
| D12 | | 0.0% | 1.18 | 1.6% | 2.02 | 2.7% | 71.99 | 95.7% | 75.19 |
| D13 | | 0.0% | 2.06 | 2.7% | | 0.0% | 75.03 | 97.3% | 77.09 |
| D14 | | 0.0% | | 0.0% | 1.24 | 3.5% | 34.21 | 96.5% | 35.45 |
| D15 | | 0.0% | 9.81 | 7.8% | 8.72 | 7.0% | 106.75 | 85.2% | 125.28 |
| D16 | | 0.0% | 0.55 | 1.2% | | 0.0% | 44.62 | 98.8% | 45.17 |
| D18 | | 0.0% | 2.21 | 5.4% | 0.01 | 0.0% | 38.49 | 94.9% | 40.71 |
| D19 | | 0.0% | 10.91 | 39.8% | 4.81 | 17.5% | 11.7 | 42.7% | 27.42 |
| D20 | | 0.0% | 0.12 | 0.4% | | 0.0% | 27.3 | 99.6% | 27.42 |
| D23 | | 0.0% | 0.31 | 1.6% | 5.63 | 28.5% | 13.84 | 70.0% | 19.78 |
| D25 | | 0.0% | 0.03 | 0.0% | 5.61 | 4.5% | 119.25 | 95.5% | 124.89 |
| D26 | | 0.0% | 0.04 | 0.1% | 15.32 | 29.1% | 37.28 | 70.8% | 52.64 |
| D27 | | 0.0% | | 0.0% | | 0.0% | 60.85 | 100.0% | 60.85 |
| D28 | | 0.0% | | 0.0% | 24.94 | 18.2% | 112.02 | 81.8% | 136.96 |
| D29 | | 0.0% | | 0.0% | | 0.0% | 31.42 | 100.0% | 31.42 |
| D30 | | 0.0% | | 0.0% | | 0.0% | 32.98 | 100.0% | 32.98 |
| D31 | | 0.0% | | 0.0% | | 0.0% | 64.31 | 100.0% | 64.31 |
| OS1 | | 0.0% | 3.9 | 26.4% | 10.65 | 72.1% | 0.22 | 1.5% | 14.77 |
| OS2 | | 0.0% | 29.99 | 77.0% | | 0.0% | 8.98 | 23.0% | 38.97 |
| OS3 | | 0.0% | 27.53 | 81.0% | | 0.0% | 6.45 | 19.0% | 33.98 |
| OS4 | | 0.0% | 1.18 | 12.4% | 7.89 | 82.7% | 0.47 | 4.9% | 9.54 |
| L1 | | 0.0% | | 0.0% | 67.82 | 100.0% | 0 | 0.0% | 67.82 |
| L2 | | 0.0% | | 0.0% | 106.42 | 35.8% | 190.92 | 64.2% | 297.34 |
| L3 | | 0.0% | | 0.0% | | 0.0% | 85.06 | 100.0% | 85.06 |
| L4 | | 0.0% | | 0.0% | 28.08 | 23.9% | 89.64 | 76.1% | 117.72 |
| L5 | | 0.0% | 16.9 | 4.7% | 212 | 59.0% | 130.4 | 36.3% | 359.3 |
| L6 | | 0.0% | | 0.0% | 33.34 | 61.4% | 20.92 | 38.6% | 54.26 |
| L7 | | 0.0% | | 0.0% | 53.36 | 61.0% | 34.09 | 39.0% | 87.45 |
| L9 | | 0.0% | | 0.0% | | 0.0% | 105.13 | 100.0% | 105.13 |
| L10 | | 0.0% | | 0.0% | 82.28 | 37.9% | 135.02 | 62.1% | 217.3 |
| C1 | 29.1 | 5.1% | | 0.0% | 38.6 | 6.8% | 501.8 | 88.1% | 569.5 |
| C2 | | 0.0% | | 0.0% | 4.4 | 5.9% | 70 | 94.1% | 74.4 |
| C3 | | 0.0% | | 0.0% | 5.7 | 9.0% | 57.8 | 91.0% | 63.5 |
| C4 | | 0.0% | 14.8 | 6.2% | 18.7 | 7.9% | 204.2 | 85.9% | 237.7 |
| C5 | | 0.0% | 0.6 | 0.3% | 21.2 | 10.3% | 184.5 | 89.4% | 206.3 |
| C6 | | 0.0% | | 0.0% | | 0.0% | 61.76 | 100.0% | 61.76 |
| C7 | | 0.0% | | 0.0% | | 0.0% | 53.19 | 100.0% | 53.19 |
| C8 | | 0.0% | | 0.0% | | 0.0% | 32.97 | 100.0% | 32.97 |
| C9 | | 0.0% | | 0.0% | | 0.0% | 47.45 | 100.0% | 47.45 |
| C10 | | 0.0% | | 0.0% | 4 | 2.3% | 170.5 | 97.7% | 174.5 |
| C11 | | 0.0% | | 0.0% | 8.66 | 10.9% | 70.57 | 89.1% | 79.23 |
| C12 | | 0.0% | | 0.0% | | 0.0% | 154.14 | 100.0% | 154.14 |

# EXHIBIT H

## POST-DEVELOPMENT SOILS ANALYSIS (SCS)

# Cordova Hills SPA

*County of Sacramento, California*

*March, 2011* *Sheet 1 of 2*

MACKAY & SOMPS
CIVIL ENGINEERS, INC.
SACRAMENTO, CALIFORNIA (916) 929-6092

7968-10

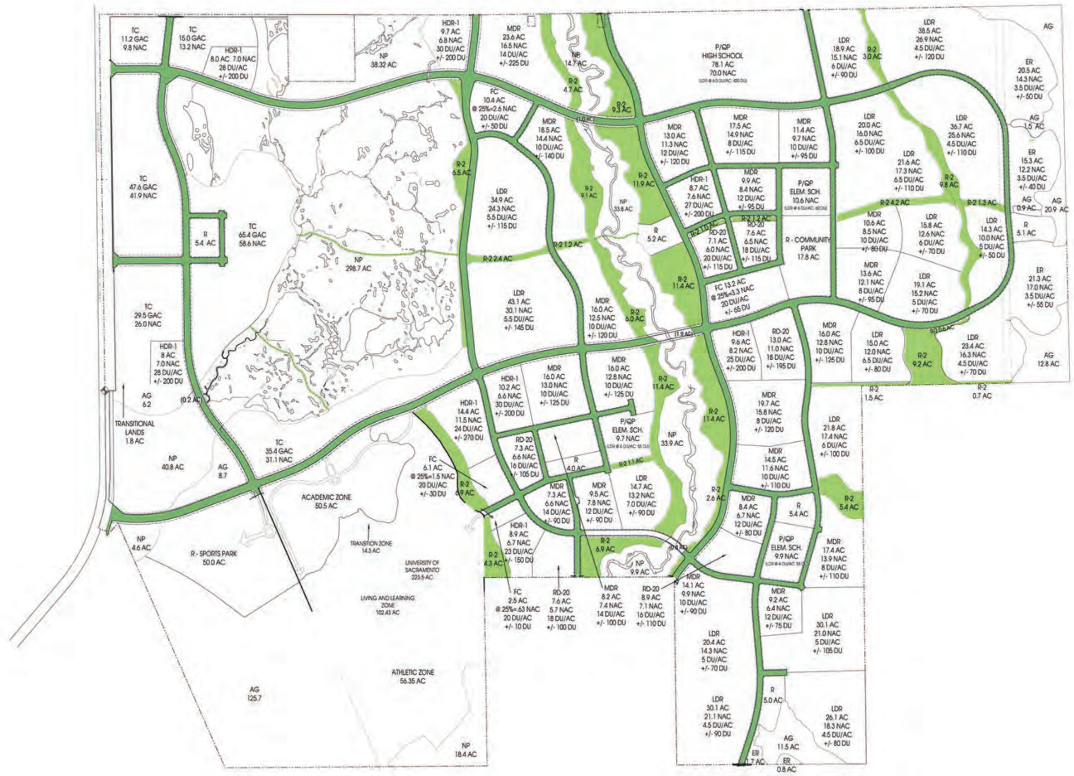
03-11-2011 3:59pm Mike Jones P:\7968\MASTER PLANS\CH-SDMP\EXHIBITS\EXHIBIT H - POST DEVELOPMENT SOILS ANALYSIS.DWG

Vegetated bio-swales in street medians intercept stormwater runoff, removing pollutants, increasing evaporation, and retarding flows prior to discharge.

Curb cuts direct runoff into bioswales and natural openspace for treatment, increased evaporation, and flow retardation.

Lush vegetated swales with native vegetation and trees intercept runoff, allowing for increased evaporation and treatment to remove pollutants prior to discharge into natural waters; permeable walkways promote infiltration, thereby reducing runoff.

Bioretention systems and raingardens capture stormwater runoff from the public right-of-way and provide water quality treatment via vegetation and bacteria in the soil medium, before discharging to subdrains.



Cordova Hills

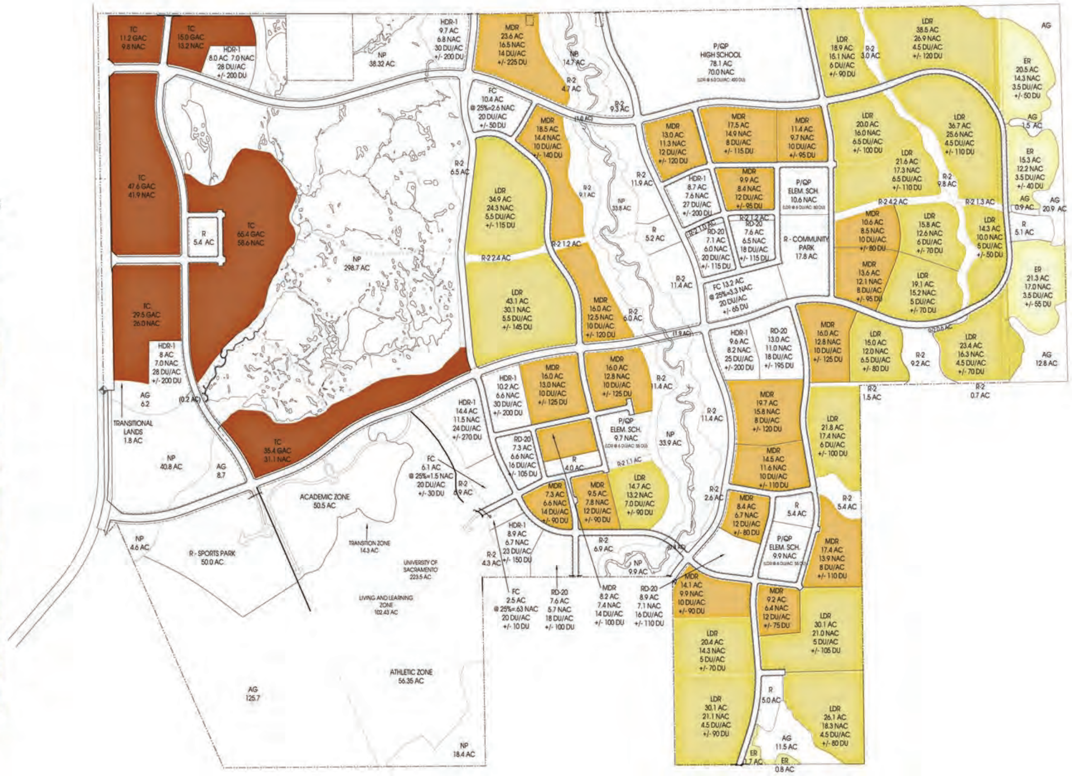
Conceptual LID Master Plan
Streets and Landscape Corridors

Trees, green ways with native vegetation, water conservation, xeriscaping, and pervious concrete walkways intercept stormwater at the source, allowing for an increased level of evaporation and infiltration, thereby lowering runoff volumes.

Residential raingardens and native landscape vegetation retain runoff for infiltration and treatment prior to discharge.

Disconnected roof drains allow runoff to be conveyed across landscaped areas into private raingardens for treatment and infiltration.

Vegetated swales for water retention and conveyance capture lot and street runoff, allowing for infiltration and treatment prior to discharge.



Cordova Hills

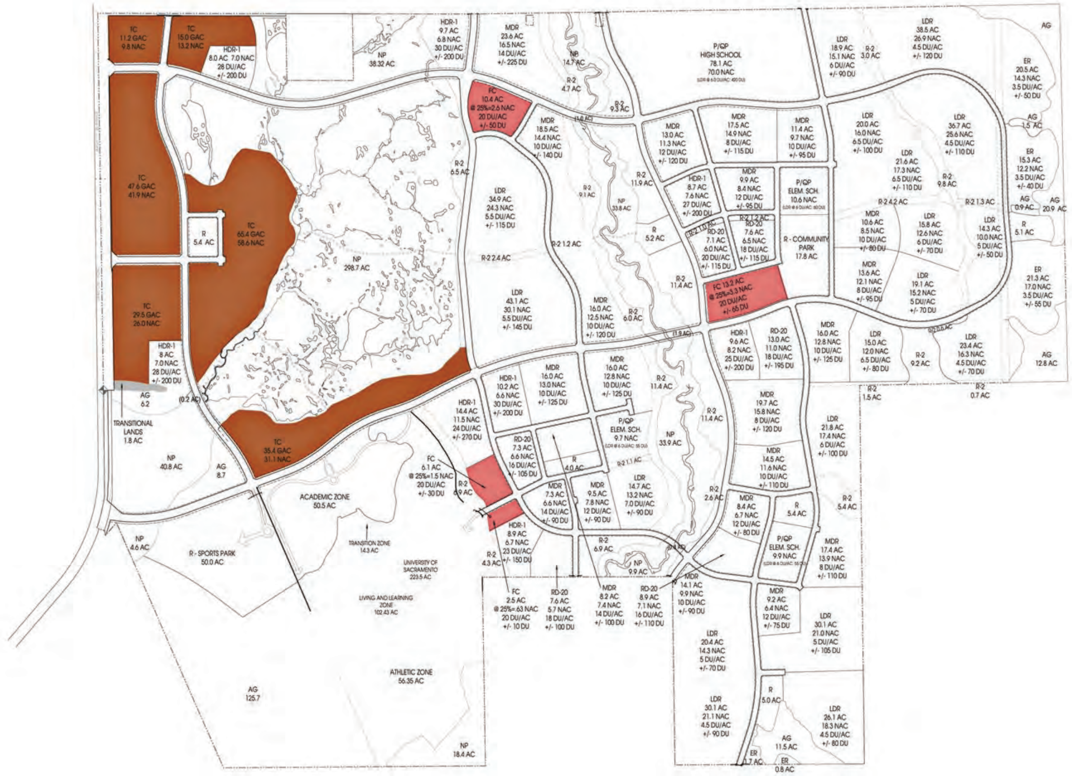
Conceptual LID Master Plan
Residential Areas
(ER, LDR, MDR, incl. TC- Residential)

Vegetated and rocked swales convey stormwater runoff in naturalized systems, promoting infiltration, water quality treatment, and retardation of runoff prior to discharge.

Permeable pavements and pavers allow stormwater infiltration, thus reducing runoff.

Bio-retention systems capture and treat stormwater runoff from impermeable surfaces, retarding the runoff in the process.

Green roofs capture rainfall at the source, promoting evaporation, treating for water quality and retarding stormwater runoff.



Cordova Hills

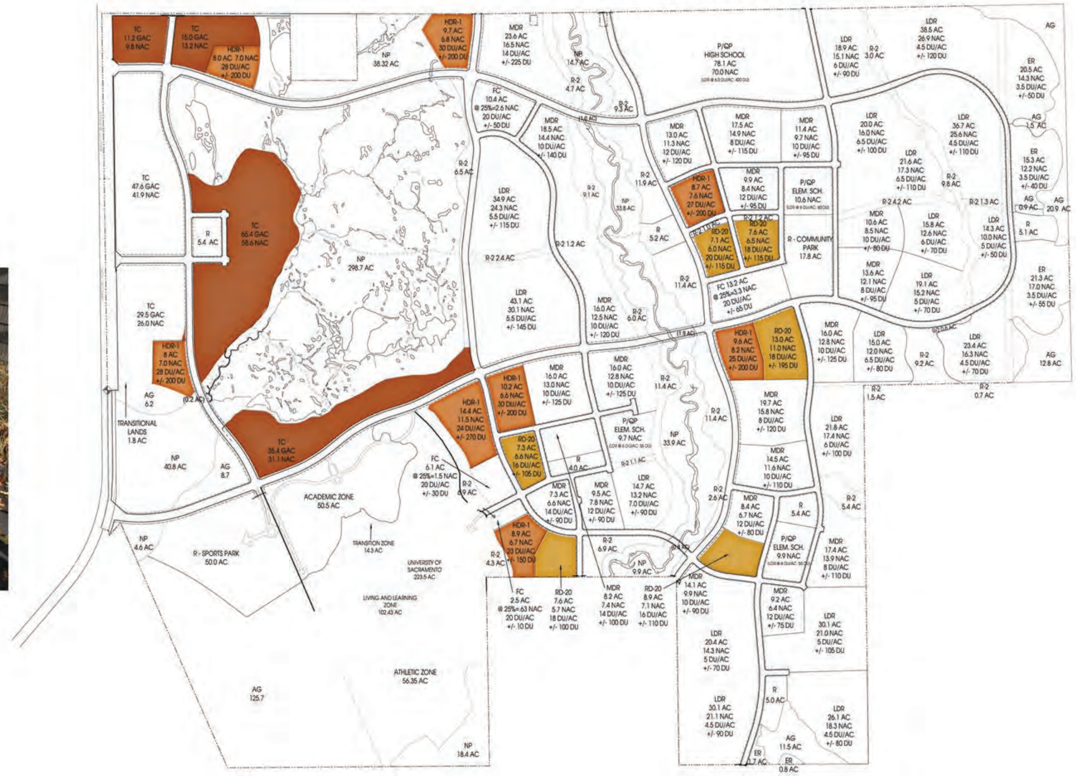
Conceptual LID Master Plan
Commercial and Employment Centers
(incl. TC- Non-redidential)

Bioswales with native vegetation capture stormwater from buildings and parking lots, retarding runoff, increasing infiltration, and treating for water quality prior to discharge.

Porous asphalt promotes infiltration of stormwater, thereby reducing runoff.

Native, drought-tolerant vegetation, xeriscaping, mulching of vegetated surfaces, and preservation of existing terrain and drainage patterns help conserve resources and minimize impacts to the watershed.

Curb breaks direct surface runoff into drainage swales and raingardens, helping reduce velocities and promoting infiltration and treatment of stormwater.



Cordova Hills

Conceptual LID Master Plan
Residential Areas
(MHDR, HDR, incl. TC- Residential)

Pervious surfaces not only enhance the character and aesthetics of active play areas, but also play an important role in enhancing stromwater infiltration at the source, thereby reducing runoff volumes; native vegetation is drought tolerant, disease resistant, and requires minimal maintenance, while providing ecological benefit and increasing rain water infiltration and flow retardation.

Densly vegetated biofiltration swales convey stormwater runoff around active recreation areas, while at the same time providing stormwater quality treatment through plant uptake and sediment settlement, increased infiltration, and overall flow retardation.

Biofiltration swales capture and convey local stormwater runoff through dense native vegetation at the edge of recreation areas, thereby providing water quality treatment, increased infiltration and evaporation, and flow retardation, without sacrificing park usability and aesthetics.

Pervious walkway surfaces allow for increased stormwater infiltration, while natural low-maintenance vegetation is drought tolerant and desease resistant, providing water quality treatment and increased infiltration and evaporation.

Cordova Hills

Conceptual LID Master Plan
Parks

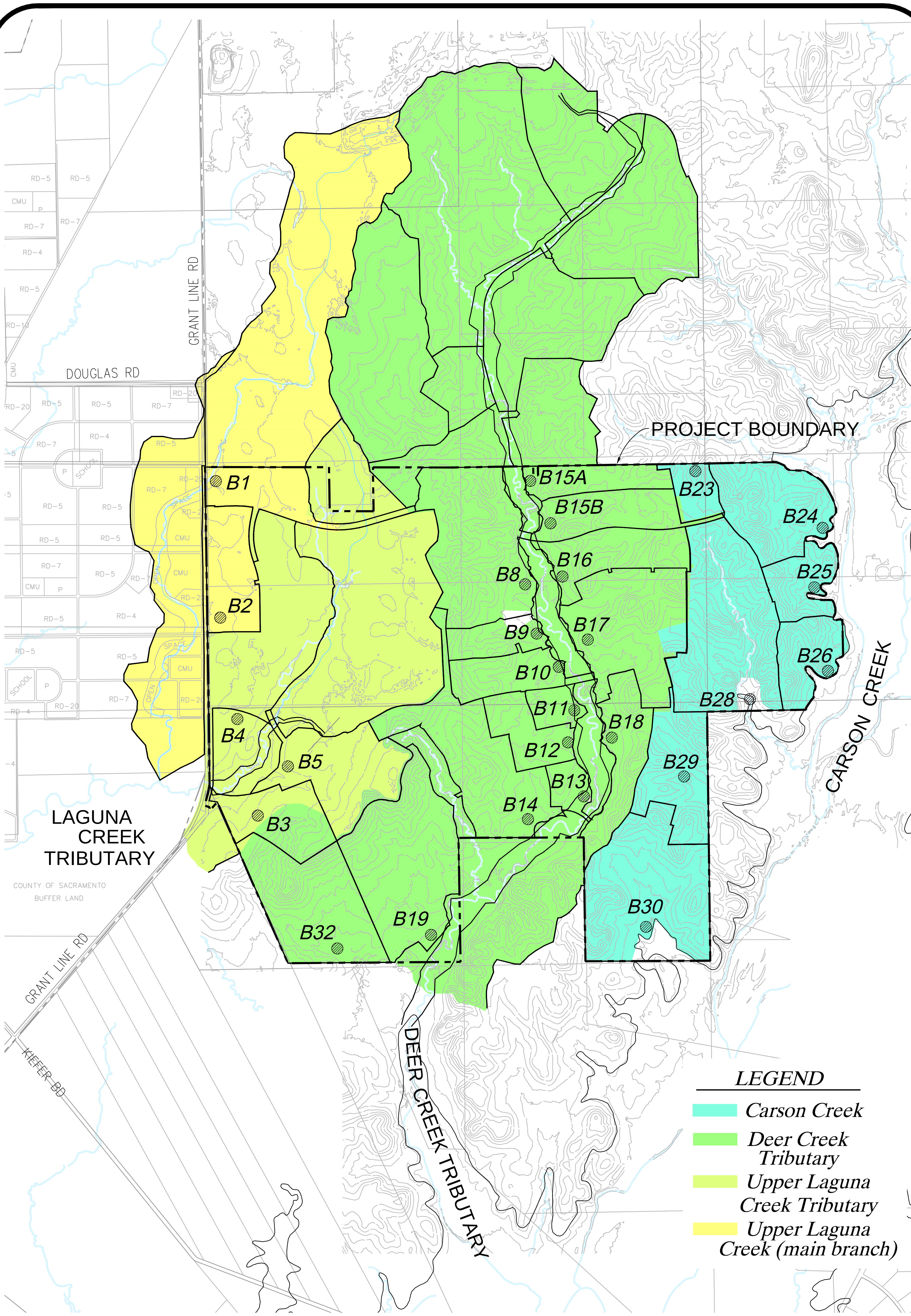



EXHIBIT J

Post-Development Watershed Map

# Cordova Hills SPA

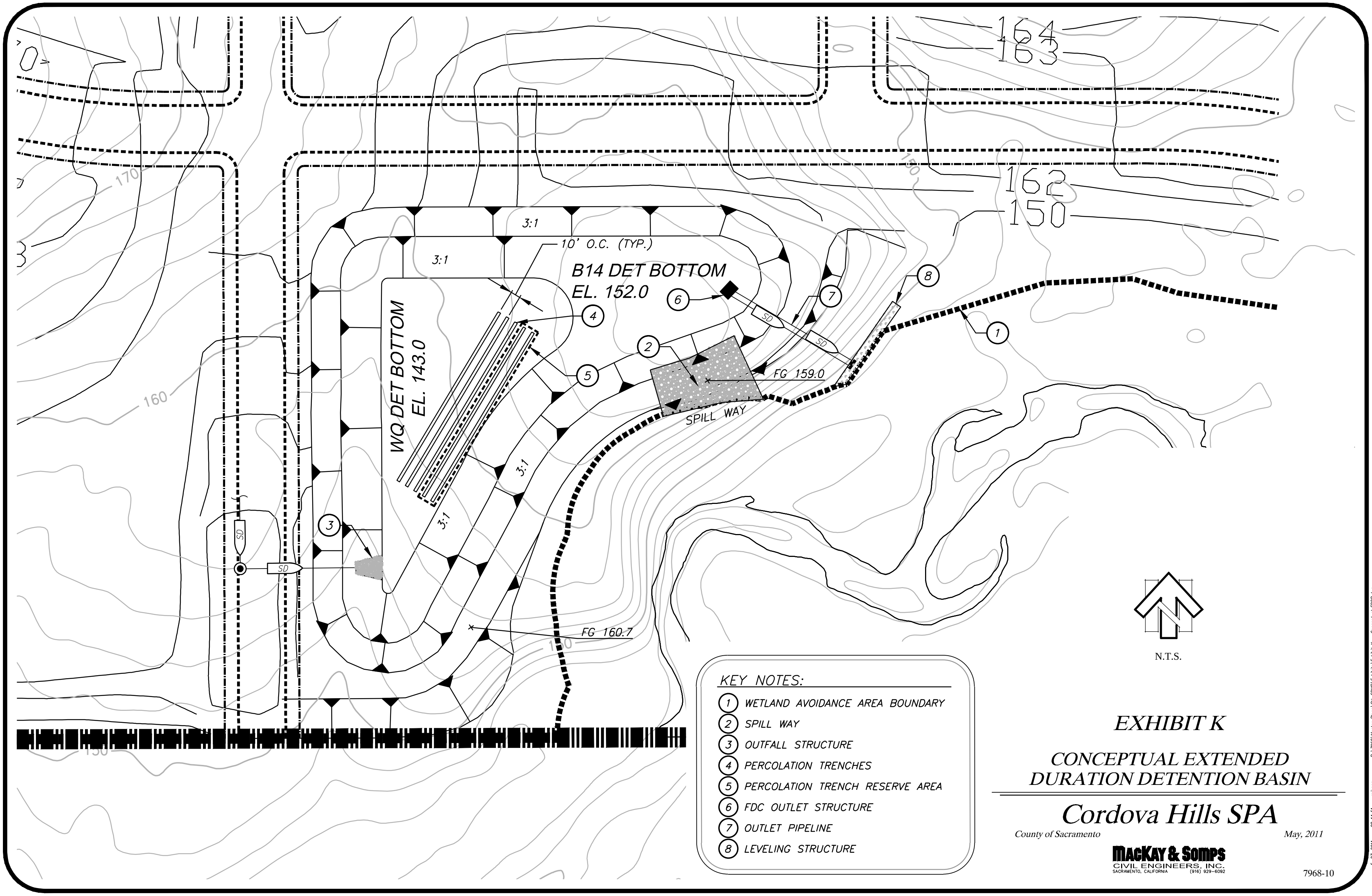
County of Sacramento, California

Scale: N.T.S. March, 2011

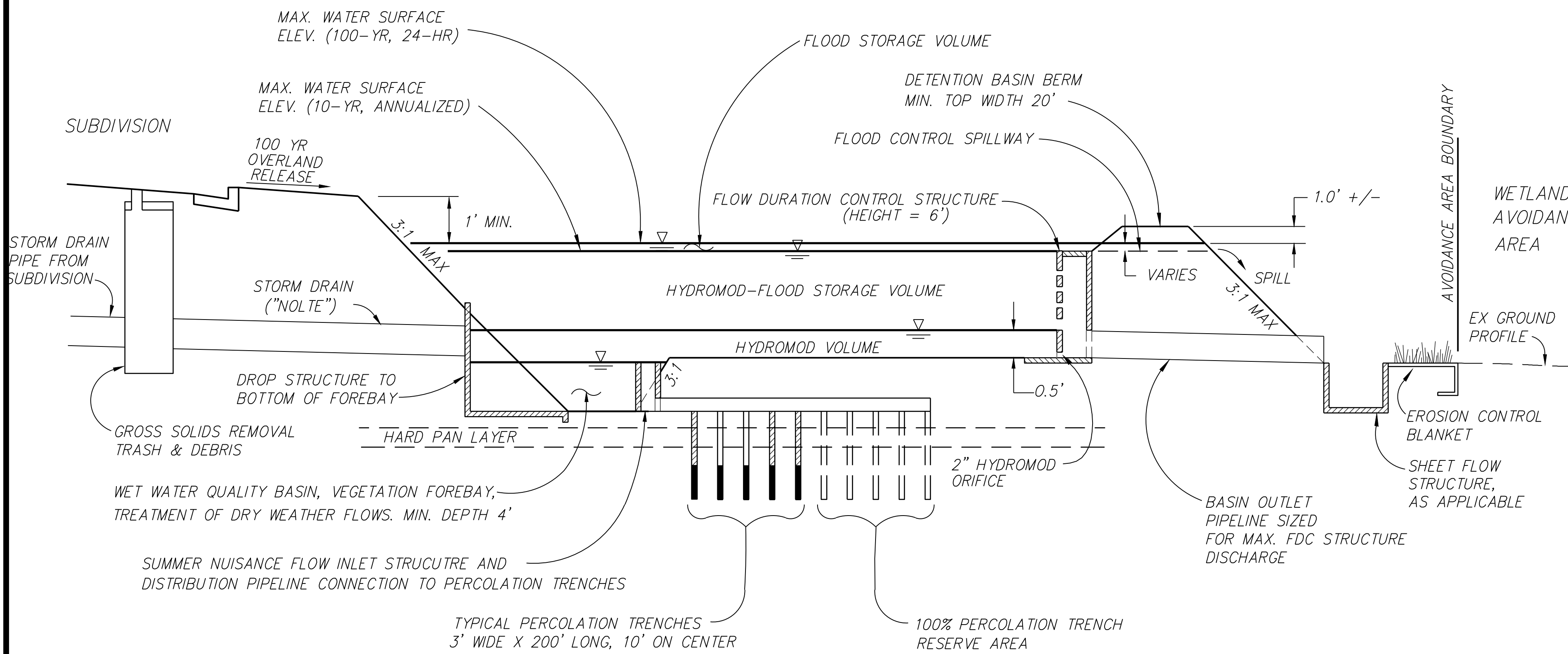
7968-10

MACKAY & SOMPS
CIVIL ENGINEERS, INC.
ROSEVILLE, CALIFORNIA (916) 773-1189

3-14-2011 14:04:05 mjones P:\7968\Master Plans\CH-SDMP\Exhibits\Exhibit J - Post Development Watershed Map.dwg
There are no xreferences in this drawing.



164
163
162
150
170
160
B14 DET BOTTOM
EL. 152.0
WQ DET BOTTOM
EL. 143.0
10' O.C. (TYP.)
3:1
SD
SPILL WAY
FG 159.0
FG 160.7
N.T.S.
KEY NOTES:
1 WETLAND AVOIDANCE AREA BOUNDARY
2 SPILL WAY
3 OUTFALL STRUCTURE
4 PERCOLATION TRENCHES
5 PERCOLATION TRENCH RESERVE AREA
6 FDC OUTLET STRUCTURE
7 OUTLET PIPELINE
8 LEVELING STRUCTURE
EXHIBIT K
CONCEPTUAL EXTENDED DURATION DETENTION BASIN
Cordova Hills SPA
County of Sacramento
May, 2011
MACKAY & SOMPS
CIVIL ENGINEERS, INC.
SACRAMENTO, CALIFORNIA (916) 929-6092
7968-10




# EXHIBIT L

## TYPICAL HYDRO-MODIFICATION DETENTION BASIN CROSS-SECTION

## Cordova Hills SPA

*County of Sacramento, California* *MAY, 2011*
*Scale: N.T.S.*

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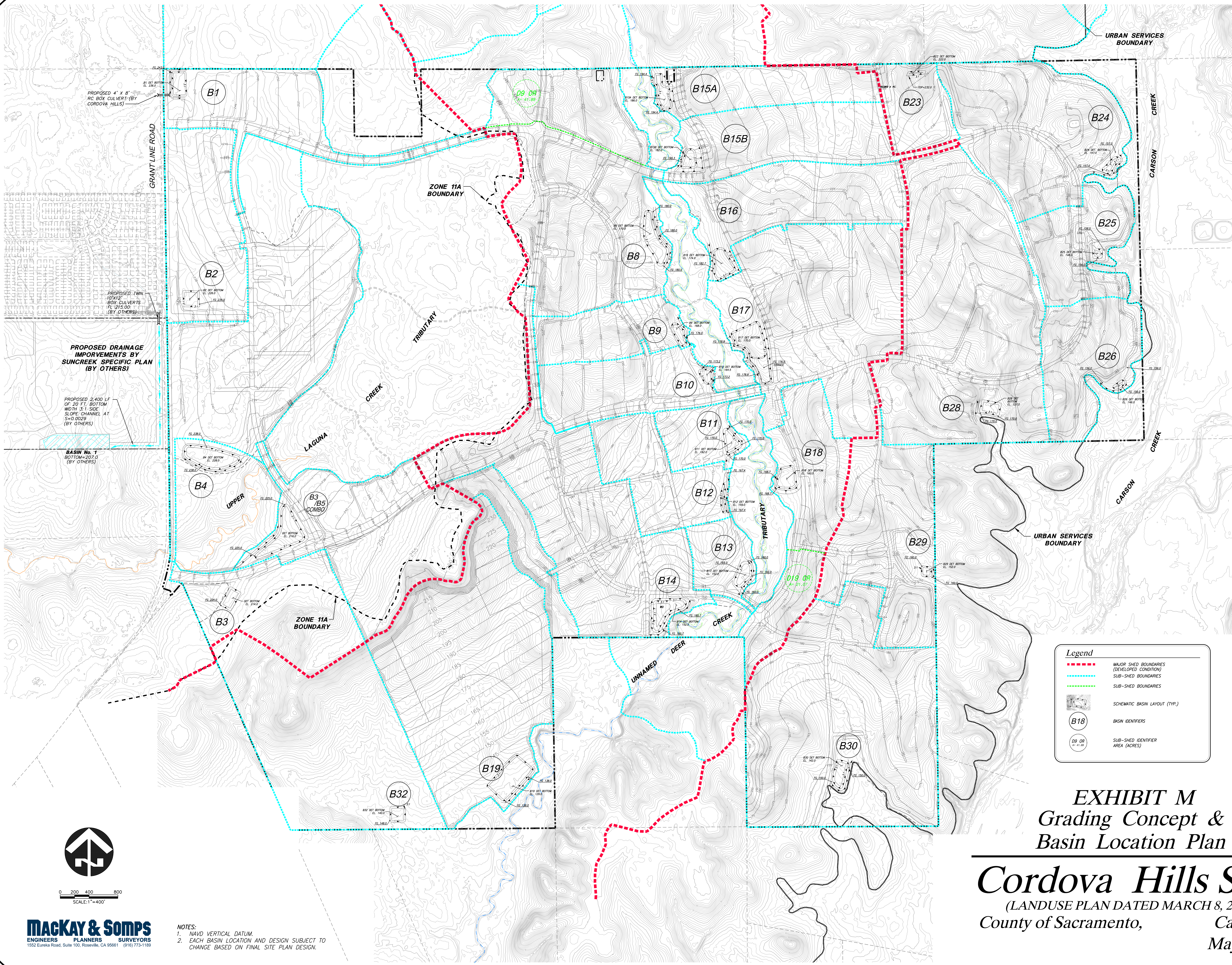
SACRAMENTO, CALIFORNIA (916) 929-6092

7968-10

P:\7968\Master Plans\CH-SDMP\Exhibits\Exhibit-L-Typ Det Basin.dwg bboraen 14:44:58 5-27-2011




NOTES:
1. NAVD VERTICAL DATUM.
2. EACH BASIN LOCATION AND DESIGN SUBJECT TO CHANGE BASED ON FINAL SITE PLAN DESIGN.

# EXHIBIT M
## Grading Concept & Basin Location Plan

# Cordova Hills SPA

(LANDUSE PLAN DATED MARCH 8, 2011)

County of Sacramento, California

May, 2011

7968-10

**TOWN CENTER (GAC)**

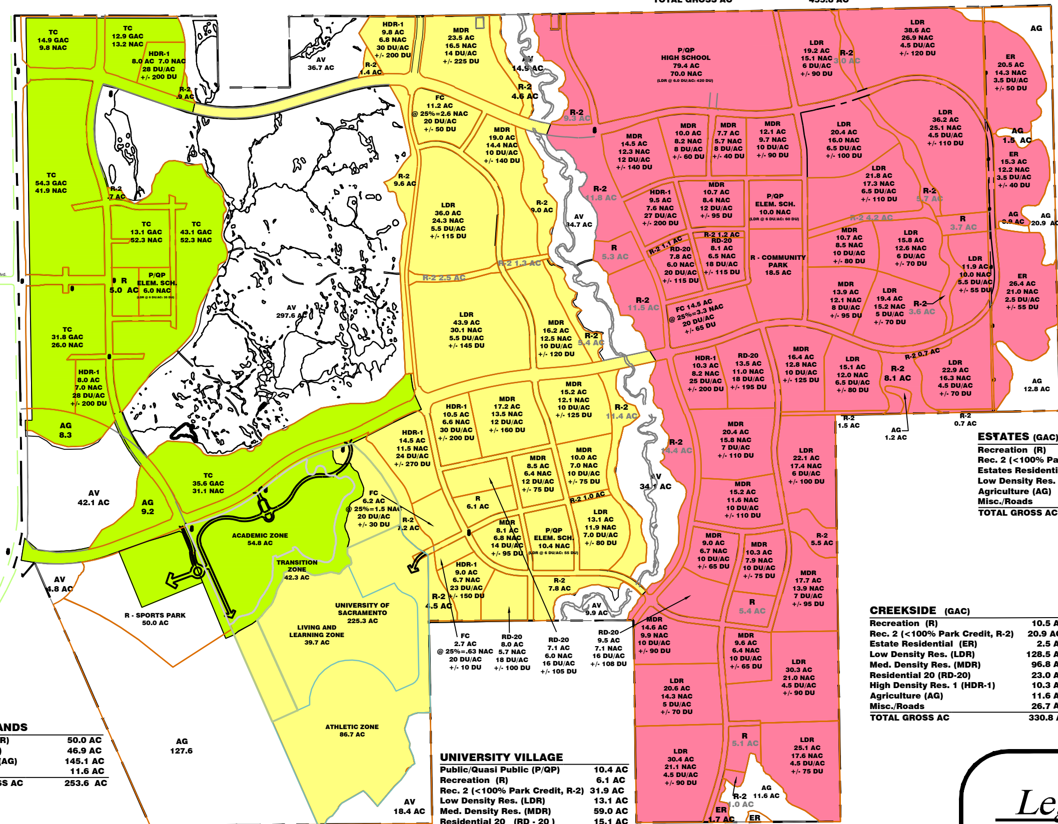
| | |
|---|---|
| Public/Quasi Public (P/QP) | 6.0 AC |
| Recreation (R) | 5.0 AC |
| Rec.2 (<100% Credit, R-2) | 3.0 AC |
| Avoided (AV) | 334.3 AC |
| Town Center (TC) | 205.7 AC |
| High Density Res. (HDR-1) | 16.0 AC |
| Misc./Roads | 62.4 AC |
| TOTAL GROSS AC | 632.4 AC |

**RIDGELINE (GAC)**

| | |
|---|---|
| Rec. 2 (<100% Park Credit, R-2) | 32.4 AC |
| Low Density Res. (LDR) | 79.9 AC |
| Med. Density Res. (MDR) | 58.7 AC |
| High Density Res. (HDR-1) | 9.8 AC |
| Flex Commercial (FC) | 11.2 AC |
| Misc./Roads | 25.9 AC |
| TOTAL GROSS AC | 217.9 AC |

**EAST VALLEY (GAC)**

| | |
|---|---|
| Public/Quasi Public (P/QP) | 89.4 AC |
| Recreation (R) | 23.8 AC |
| Rec. 2 (<100% Park Credit, R-2) | 48.7 AC |
| Low Density Res. (LDR) | 111.7 AC |
| Med. Density Res. (MDR) | 96.0 AC |
| Residential 20 (RD-20) | 15.9 AC |
| High Density Res. (HDR-1) | 9.5 AC |
| Flex Commercial (FC) | 14.5 AC |
| Agriculture (AG) | 1.2 AC |
| Misc./Roads | 45.1 AC |
| TOTAL GROSS AC | 455.8 AC |



**ESTATES (GAC)**

| | |
|---|---|
| Recreation (R) | 3.7 AC |
| Rec. 2 (<100% Park Credit, R-2) | 13.7 AC |
| Estates Residential (ER) | 62.2 AC |
| Low Density Res. (LDR) | 109.6 AC |
| Agriculture (AG) | 36.1 AC |
| Misc./Roads | 11.4 AC |
| TOTAL GROSS AC | 236.7 AC |

**CREEKSIDE (GAC)**

| | |
|---|---|
| Recreation (R) | 10.5 AC |
| Rec. 2 (<100% Park Credit, R-2) | 20.9 AC |
| Estate Residential (ER) | 2.5 AC |
| Low Density Res. (LDR) | 128.5 AC |
| Med. Density Res. (MDR) | 96.8 AC |
| Residential 20 (RD-20) | 23.0 AC |
| High Density Res. 1 (HDR-1) | 10.3 AC |
| Agriculture (AG) | 11.6 AC |
| Misc./Roads | 26.7 AC |
| TOTAL GROSS AC | 330.8 AC |

**BUFFERLANDS**

| | |
|---|---|
| Recreation (R) | 50.0 AC |
| Avoided (AV) | 46.9 AC |
| Agriculture (AG) | 145.1 AC |
| Misc./Roads | 11.6 AC |
| TOTAL GROSS AC | 253.6 AC |

**UNIVERSITY VILLAGE**

| | |
|---|---|
| Public/Quasi Public (P/QP) | 10.4 AC |
| Recreation (R) | 6.1 AC |
| Rec. 2 (<100% Park Credit, R-2) | 31.9 AC |
| Low Density Res. (LDR) | 13.1 AC |
| Med. Density Res. (MDR) | 59.0 AC |
| Residential 20 (RD - 20 ) | 15.1 AC |
| High Density Res. 1 (HDR-1) | 34.0 AC |
| Flex Commercial (FC) | 8.9 AC |
| Misc./Roads | 23.6 AC |
| TOTAL GROSS AC | 202.1 AC |

**CORDOVA HILLS**
**LAND USE SUMMARY**

| | |
|---|---|
| PUBLIC/QUASI PUBLIC (P/QP) | 105.8 AC |
| RECREATION (R) | 99.1 AC |
| REC. 2 (<100% PARK CREDIT, R-2) | 150.6 AC |
| AVOIDED (AV) | 493.2 AC |
| ESTATES RES. (ER) 1 - 4 DU/AC | 64.7 AC |
| LOW DENSITY RES. (LDR) 4 - 7 DU/AC | 442.8 AC |
| MED. DENSITY RES. (MDR) 7 - 15 DU/AC | 310.5 AC |
| RESIDENTIAL - 20. (RD-20) 15 - 23 DU/AC | 54.0 AC |
| HIGH DENSITY RES. 1 (HDR-1) 23 - 30 DU/AC | 79.6 AC |
| FLEX COMMERCIAL (FC) | 34.6 AC |
| TOWN CENTER (TC) | 205.7 AC |
| UNIVERSITY OF SACRAMENTO | 223.5 AC |
| AGRICULTURE (AG) | 194.0 AC |
| MISC ROADS & OPEN SPACE | 210.4 AC |
| **TOTAL GROSS ACREAGE** | **2,668.5 AC** |

*Legend*

*Phase 1*

*Phase 2*

*Phase 3*

*NOTE: All facilities associated with each Phase shall be built in total, no interim facilities are anticipated.*

0 2500 5000

SCALE: 1"=2500'

MACKAY & SOMPS
CIVIL ENGINEERS, INC.
ROSEVILLE, CALIFORNIA (916) 773-1189

# EXHIBIT N
## Development Phasing

# Cordova Hills SPA
(Land Use Plan Dated March 8, 2011)
Sacramento County, California
May, 2011

7968-10


EXHIBIT 'O'

Upper Laguna Creek Tributary
Post-Development Watershed Map

# Cordova Hills SPA

County of Sacramento, California
Scale: 1"=300' May, 2011

MacKAY & SOMPS
ENGINEERS PLANNERS SURVEYORS
1552 Eureka Road, Suite 100, Roseville, CA 95661 (916) 773-1189

7968-10